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JAPANESE [JP,10-032557,A]

CLAIMS DETAILED DESCRIPTION TECHNICAL FIELD PRIOR ART EFFECT OF THE INVENTION TECHNICAL PROBLEM MEANS DESCRIPTION OF DRAWINGS DRAWINGS

[Translation done.]

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CLAIMS

[Claim(s)]
[Claim 1] After modulating the information which a sending set should transmit by the predetermined modulation technique, it transmits with predetermined frequency. After repeating installation receives and restores to the electric wave which said sending set transmitted, it becomes irregular again. Said information which should be transmitted In the relay system which it retransmits a message [relay system] using the same frequency as said sending set, and makes the transmitted electric wave from both said sending set, and both [one side or] receive with a receiver said sending set While superimposing the signal for repeating installation for said repeating installation to retransmit a message, and the signal for receivers for transmitting to said receiver directly by hierarchization, it becomes irregular and transmits to the 1st orthogonal frequency division multiplex signal. Said repeating installation is a relay system characterized by becoming irregular again and retransmitting a message as 2nd orthogonal frequency division multiplex signal after receiving the electric wave which said sending set transmitted and carrying out the separation recovery of said signal for repeating installation.
[Claim 2] The information which should be transmitted with the delay circuit equivalent to the time amount of the sum of the radio-wave-propagation time amount from a transmitting point to a relay point, and the signal-processing time amount of said repeating installation which carries out time delay and outputs the signal for receivers, and this signal for receivers The hierarchy modulation circuit which said information which is inputted into said delay circuit, and which should be transmitted is inputted as a signal for repeating installation, and assigns the signal for these receivers, and the signal for repeating installation to a bit different, respectively, hierarchizes them, and carries out an orthogonal frequency division multiplex modulation, The sending set used for the relay system according to claim 1 characterized by having the transmitting section which changes the output modulating signal of this hierarchy modulation circuit into a predetermined frequency band, and transmits.
[Claim 3] The sending set according to claim 2 characterized by setting it as said delay circuit by making the greatest time amount into a time delay among the time amount which added the signal-processing time amount of two or more of said repeating installation arranged in the information which should be transmitted at each radio-wave-propagation time amount from a transmitting point to two or more relay points of each at this each relay point when there is two or more said repeating installation.
[Claim 4] said hierarchy modulation circuit -- said signal for receivers -- low -- degree side -- and the sending set according to claim 2 or 3 characterized by hierarchizing said signal for repeating installation to a high order side.
[Claim 5] Said hierarchy modulation circuit is a sending set according to claim 2 or 3 characterized by outputting the orthogonal frequency division multiplex signal with which it hierarchized by non uniform 16QAM or non uniform 16DAPSK, and each of two or more subcarriers was modulated by this non uniform 16QAM or non uniform 16DAPSK.
[Claim 6] The repeating installation which uses for the relay system according to claim 1 characterized by to have the receive section which receives the electric wave which said sending set transmitted, the hierarchy demodulator circuit which recovers said signal for

repeating installation from the signal which this receive section received, the modulation circuit which outputs the orthogonal frequency division multiplex signal which modulated this signal for repeating installation to which it restored by the predetermined modulation technique, and the transmitting section which changes the output signal of this modulation circuit into the same frequency band as said sending set, and transmit.

[Claim 7] Repeating installation according to claim 6 characterized by establishing the delay circuit for making mostly in agreement the transmitting time of day of said sending set, and the time of day which self-equipment transmits in the input side or output side of said hierarchy demodulator circuit.

[Claim 8] Said modulation circuit is repeating installation according to claim 5 or 6 characterized by each of two or more subcarriers carrying out the generation output of the orthogonal frequency division multiplex by which the QPSK modulation was carried out by said signal for repeating installation.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the sending set and repeating installation which are used for the relay system and this to which the sending set and repeating installation which are used for a relay system and this are started, especially a receiver receives an orthogonal frequency division multiplex signal from both a sending set, and both [one side or].
[0002]
[Description of the Prior Art] As a modulation technique of ground digital broadcast, the orthogonal frequency division multiplex (OFDM) method is examined. An OFDM method can establish the redundant period called a guard interval, and has very strong resistance as compared with the digital broadcasting format of a single carrier method to the ghost (multi-pass) of the time delay within this guard interval period. For this reason, the junction by the single frequency called a single frequency network (SFN) is attained, and a receiver can receive the orthogonal frequency division multiplex signal of the same contents on the same frequency from both a sending set, and both [one side or].
[0003] Moreover, it is also possible to maintain a stable transmission condition to transmission and reception in the location to which this is used for and field strength, such as a building shadow, falls with the repeating installation (retransmission-of-message equipment) which uses the same frequency called a gap filler.
[0004]
[Problem(s) to be Solved by the Invention] However, when acting as intermediary using a single frequency, in order for the repeating installation formed at a relay point to receive the electric wave of a sending set prepared in the transmitting point, to amplify it as it is and to broadcast it again, The signal to broadcast again becomes a thing with a time lag required for signal processing (magnification) of the repeating installation itself at the radio-wave-propagation time lag list between a transmitting point and a relay point. As a result of producing time difference between the electric wave transmitted from a sending set, and the electric wave to which it retransmits a message from repeating installation, a ghost's (multi-pass) time delay difference in a receiving point becomes large.
[0005] In a receiving point, that the time delay difference between the electric wave transmitted from a sending set and the electric wave to which it retransmits a message from repeating installation becomes the largest is the case where a receiving point is located on the straight line which ties a sending set and repeating installation, and see from a sending set and a receiving point is located in the direction where repeating installation is opposite. The time delay difference in this case becomes what added time amount required for signal processing (magnification) of the repeating installation itself the twice of the radio-wave-propagation time amount between a sending set and repeating installation.
[0006] In order to suppress such a time delay difference within the period of the guard interval of an OFDM signal, it is necessary to narrow distance of a sending set and repeating installation conventionally, or to lengthen the period of a guard interval. Moreover, in the above-mentioned conventional relay system, when the ghost (multi-pass) who has a time delay exceeding the

period of a guard interval exists, the transmission quality deteriorates rapidly. On the other hand, a guard interval is a redundant period and lengthening this period causes the fall of transmission capacity.

[0007] On the other hand, the number network (DFN) of dual tone multifrequencies which uses two frequency bands conventionally is proposed (the collection of "examination of ground digital broadcast-2 cycle broadcast junction (DFN) by OFDM" 1995 television society annual meeting [besides Aiichiro Tsujiku] drafts, 277 pages - 278 pages). Since this DFN is a method which repeats two frequencies per program by turns, and uses them, deterioration of the transmission quality by the ghost is mitigated by adopting this DFN.

[0008] However, since this DFN uses two frequency bands, frequency use effectiveness is worse than SFN, and it is difficult effectiveness to use two frequency bands in the case of the junction of a program material. Furthermore, in DFN, an addressee needs to choose two frequency bands according to a receiving point, needs to receive, and is not suitable for migration reception.

[0009] This invention was made in view of the above point, and aims to let a sending set and repeating installation offer the sending set and repeating installation which are used for the relay system and this which can make small the time delay difference in the receiving point of the electric wave transmitted from a sending set, and the electric wave to which it retransmits a message from repeating installation in SFN using the same frequency.

[0010] Moreover, other purposes of this invention are to offer the sending set and repeating installation which are used for the relay system and this which shorten long-distance-izing of the distance of a sending set and repeating installation, or the period of the guard interval which is a redundant period, and can enlarge transmission capacity.

[0011]

[Means for Solving the Problem] In order to attain the above-mentioned purpose, the relay system of this invention After modulating the information which a sending set should transmit by the predetermined modulation technique, it transmits with predetermined frequency. The information which should modulate again and should be transmitted after repeating installation receives and restores to the electric wave which the sending set transmitted In the relay system which it retransmits a message [relay system] using the same frequency as a sending set, and makes the transmitted electric wave from both a sending set, and both [one side or] receive with a receiver a sending set While superimposing the signal for repeating installation for repeating installation to retransmit a message, and the signal for receivers for transmitting to a receiver directly by hierarchization, it becomes irregular and transmits to the 1st orthogonal frequency division multiplex signal. After repeating installation receives the electric wave which the sending set transmitted and carries out the separation recovery of the signal for repeating installation, it is characterized by becoming irregular again and retransmitting a message as 2nd orthogonal frequency division multiplex signal.

[0012] In this invention, since the signal for receivers turned to the receiver from the sending set is overlapped on the signal for repeating installation towards repeating installation, each signal can be transmitted to coincidence towards both a receiver and repeating installation from the same transmitting section in a sending set.

[0013] In order to attain the above-mentioned purpose, moreover, the sending set of this invention The information which should be transmitted with the delay circuit equivalent to the time amount of the sum of the radio-wave-propagation time amount from a transmitting point to a relay point, and the signal-processing time amount of repeating installation which carries out time delay and outputs the signal for receivers, and the signal for receivers The hierarchy modulation circuit which the information which is inputted into a delay circuit, and which should be transmitted is inputted as a signal for repeating installation, and assigns the signal for these receivers, and the signal for repeating installation to a bit different, respectively, hierarchizes them, and carries out an orthogonal frequency division multiplex modulation, It considers as the configuration which has the transmitting section which changes the output modulating signal of a hierarchy modulation circuit into a predetermined frequency band, and transmits.

[0014] The signal for receivers directly turned to the receiving point, without minding repeating installation among the signals transmitted from a sending set is the information for which only

the time amount which added time amount required for signal processing (magnification, a recovery, second change tone) of the repeating installation itself to the radio-wave-propagation time amount between a transmitting point and a relay point from the sending set to the signal for repeating installation towards repeating installation was delayed by the delay circuit. For this reason, in this invention, the transmit timing of the signal for receivers transmitted to a receiver can be made mostly in agreement, and these signals serve as the always same contents of information from the signal to which it retransmits a message from repeating installation to a receiver, and a sending set in a sending set and repeating installation.

[0015] Consequently, in a receiver, when the time delay difference between the electric wave transmitted from a sending set and the electric wave to which it retransmits a message from repeating installation becomes the largest, that time delay difference does not exceed the radio-wave-propagation time amount between a sending set and repeating installation. Therefore, as compared with the conventional relay system, 1/2 or less is the time delay difference between the electric wave transmitted from the sending set in a receiver, and the electric wave to which it retransmits a message from repeating installation.

[0016] Moreover, the inside of the time amount which added the signal-processing time amount of two or more repeating installation arranged at each relay point in the information which should be transmitted at each radio-wave-propagation time amount from a transmitting point to two or more relay points of each when a sending set had two or more repeating installation in this invention, Since it considers as the configuration set as the delay circuit by making the greatest time amount into a time delay and the delay circuit for repeating installation to make mostly in agreement the transmitting time of day of a sending set and the time of day which self-equipment transmits was established in the input side or output side of a hierarchy demodulator circuit, The transmit timing of the signal to which it retransmits a message from two or more repeating installation to a receiver, and the signal for receivers transmitted to a receiver from a sending set can be made mostly in agreement.

[0017] furthermore -- this invention -- a hierarchy modulation circuit -- the signal for receivers -- low -- degree side -- and although the signal for repeating installation is written as the configuration which carries out a hierarchy modulation at a high order side and receiving station important point C/N in repeating installation becomes high, the electric wave from a sending set is receivable by C/N higher than a common receiver with the repeating installation which can be installed in the good place of receiving environments, such as the roof of a building.

[0018]

[Embodiment of the Invention] Next, the gestalt of operation of this invention is explained with a drawing.

[0019] Drawing 1 shows the block diagram of the gestalt of operation of the 1st of the sending set used for the relay system and this which become this invention, and repeating installation. The relay system of the gestalt of this operation has the description in the point that a sending set 1 and repeating installation 11 transmit the OFDM signal of the same contents on the same frequency, a receiver 25 is the method which receives that OFDM signal, a sending set 1 has the hierarchy modulation circuit 3, and repeating installation 11 has the hierarchy demodulator circuit 14.

[0020] It consists of the transmitted high-frequency sections 4 which a sending set 1 carries out frequency conversion of the output signal of the delay circuit 2 delayed in the information which should be transmitted, the hierarchy modulation circuit 3 which the information to which the output signal of this delay circuit 2 should transmit as a signal a for receivers is inputted as a signal b for repeating installation, respectively, hierarchizes these signals, and carries out an OFDM modulation, and the hierarchy modulation circuit 3 to magnification and the transmitting band of a RF, and transmit through aerial 5. in addition -- the hierarchy modulation circuit 3 -- the signal a for receivers -- low -- the signal b for repeating installation carries out a hierarchy modulation at a high order (non-receipt at time of low C / N) side at degree (it is ability ready for receiving also at the time of a low carrier power pair noise power ratio (C/N)) side. The hierarchy modulation circuit 3 consists of a mapping circuit 6, and the reverse fast-Fourier-transform (IFFT) circuit 7 and the quadrature modulation circuit 8, as shown in the block diagram

of drawing 2 .

[0021] The aerial 12 where repeating installation 11 receives the electric wave 21 from a sending set 1, The received radio-frequency head 13 which extracts the signal of a necessary frequency band and is amplified from the input signal from aerial 12, The hierarchy demodulator circuit 14 which carries out the OFDM recovery of the received RF signal from the received radio-frequency head 13, separates the hierarchized signal, and acquires the signal c for repeating installation which is a signal by the side of a high order further, It consists of aerial 17 which transmits the output RF signal of the modulation circuit 15 which carries out the OFDM modulation of the signal c for repeating installation, the transmitted radio-frequency head 16 which changes the output OFDM signal of a modulation circuit 15 into magnification and a high-frequency band, and the transmitted radio-frequency head 16 as an electric wave 23. The hierarchy-demodulator-circuit-14-consists-of-a rectangular demodulator 18, a fast-Fourier-transform (FFT) circuit 19, and a distinction circuit 20, as shown in the block diagram of drawing 3 .

[0022] In addition, let the frequency of the electric wave 23 transmitted from aerial 17 be the same frequency as the electric waves 21 and 22 from a sending set 1. Moreover, a receiver 25 restores to the electric wave 22 transmitted from the sending set 1, and the electric wave 23 transmitted from repeating installation 11 after reception in aerial 24.

[0023] Next, drawing 4 and drawing 5 are combined and referred to about actuation of the gestalt of this operation, and it explains to a detail. Drawing 4 (A) is drawing showing the physical relationship of the transmitting point 31 that the sending set 1 was installed, the relay point 32 when repeating installation 11 was installed, and the receiving point 33 which is the location of a receiver 25. t1, t2, and t4 show the time delay which the radio wave propagation between the transmitting point 31, between the receiving points 33 and the transmitting point 31, and a relay point 32 and between a relay point 32 and the receiving point 33 takes, respectively, and t3 shows the processing time in the repeating installation 11 installed at the relay point 32, i.e., a time delay required for retransmission of message.

[0024] At the receiving point 33, the electric wave 34 sent from the transmitting point 31 and the electric wave 36 sent from a relay point 32 are received to coincidence. Supposing the repeating installation 11 installed at the relay point 32 only amplifies the electric wave 35 sent from the transmitting point 31 and broadcasts it again now, while the electric wave 34 sent from the transmitting point 31, and the electric wave 36 sent from a relay point 32 (t2+t3+t4-t1), a time delay difference will be produced at the receiving point 33.

[0025] Drawing 4 (B) is drawing showing the time relation in the receiving point 33 of the signal 37 of the electric wave 34 at this time, and the signal 38 of an electric wave 36. Although signals 37 and 38 are signals of the same contents, the time delay difference t5 is produced. This time delay difference t5 is said time delay difference (t2+t3+t4-t1). Each signal 37 and 38 constitutes one symbol from information d1 and a guard interval d2. In an OFDM recovery, the period of the die length equivalent to the part of information d1 is extracted from the period of the arbitration within this 1 symbol period.

[0026] In drawing 4 (B), the recovery section t6 is equivalent to this. However, the time delay difference t5 of a signal 37 and a signal 38 is large, and when a signal 37 and a signal 38 are compounded, the symbol interference section t7 is produced. In this symbol interference section t7, since a symbol with different information is compounded, an error is produced to original information after a recovery. That is, when the time delay difference t5 is longer than the period of the guard interval d2, the symbol interference section t7 which is equivalent to the time difference at least is produced, and an error is produced.

[0027] The gestalt of this operation sets the time delay difference t5 to (t4-t1) by compensating the time delay which is equivalent to a sending set 1 and repeating installation 11 showing to drawing 4 (A) (t2+t3) for the purpose of not producing this symbol interference section. Drawing 4 (C) shows the time relation in the receiving point 33 of the signal 37 of the electric wave 34 at this time, and the signal 38 of an electric wave 36. As shown in this drawing, the time delay difference t5 is shorter than the period of the guard interval d2, and does not produce the symbol interference section.

[0028] Next, a hierarchy modulation is explained with drawing 5 . Drawing 5 (A) shows the constellation of non uniform 16QAM (quadrature amplitude modulation), and four digits in drawing show the 4-bit sign assigned to each signal point. 2 bits of high orders of several characters each support the quadrant in which each signal point is located, and 2 bits of low order support the location of the signal point in each quadrant. Although the distance of each sign is large and transmission with low [C/N] is possible about 2 bits of high orders, about 2 bits of low order, the distance of each sign is small and C/high N is required as compared with 2 bits of high orders. therefore -- low -- a hierarchy modulation is attained by assigning the information on degree (it being ability ready for receiving also at the time of low C / N) side to 2 bits of high orders, and assigning the information by the side of a high order (non-receipt at the time of low C / N) to 2 bits of low order.

[0029] Moreover, about 2 bits of high-orders, the same-figure as the constellation of QPSK (4 phase phase modulation) shown in drawing 5 (B) is assigned. therefore, the inside of the signal of non uniform 16QAM shown in drawing 5 (A) -- low -- when what is necessary is to be able to receive only the signal of degree (it is ability ready for receiving also at the time of low C / N) side, it can process as a signal of QPSK which shows the signal of non uniform 16QAM to drawing 5 (B).

[0030] Drawing 5 (C) shows the constellation of non uniform 16DAPSK (differential amplitude phase modulation). Four digits in drawing show the 4-bit sign assigned to each signal point. Also in this case, as well as non uniform 16QAM, 2 bits of high orders support the quadrant in which each signal point is located, and 2 bits of low order support the location of the signal point in each quadrant. therefore -- the same -- low -- when what is necessary is to be able to receive only the signal of degree (it is ability ready for receiving also at the time of low C / N) side, it can process as a signal of QPSK which shows the signal of non uniform 16DAPSK to drawing 5 (B).

[0031] Information which should be transmitted in a sending set 1 for returning to drawing 1 again and explaining actuation is carried out 2 ****s, and predetermined time delay of one side is carried out by the delay circuit 2. Let this time delay be the time amount adding the time amount (t3 of drawing 4 (A)) which signal processing of repeating installation 11 takes at the time amount (t2 of drawing 4 (A)) to which an electric wave 21 spreads between a sending set 1 and repeating installation 11. Therefore, in the example shown in drawing 4 (A), this time delay is set as (t2+t3), and sets the time delay difference t5 to (t4-t1). The signal delayed by the delay circuit 2 turns into the signal a for receivers. By defining the time delay of a delay circuit 2 in this way, information can be transmitted from a sending set 1 and repeating installation 11 to the same timing.

[0032] Another side of the information which was distributed two times and which should be transmitted is directly supplied to the hierarchy modulation circuit 3 as a signal b for repeating installation. The hierarchy modulation circuit 3 receives the above-mentioned signal b for repeating installation, and the signal a for receivers from a delay circuit 3 as an input signal, and after hierarchizing these, it performs an OFDM modulation. Namely, while the data is assigned to each subcarrier which constitutes an OFDM signal in the mapping circuit 6, the signal a for receivers which the hierarchy modulation circuit 3 is considered as the configuration shown in the block diagram of drawing 2 , and was inputted, and the signal b for repeating installation the I [which is shown in drawing 5 (A) or drawing 5 (C)], and Gauss-Argand plane top which consists of a Q-axis -- the signal a for receivers, and the signal b for repeating installation -- respectively -- low -- it hierarchizes by being arranged at a degree and high order side.

[0033] here, non uniform 16DAPSK of the constellation shown in non uniform 16QAM and this drawing (C) of the constellation shown in drawing 5 (A) is used for hierarchization, 2 bits (low -- degree (ready for receiving also at the time of low C / N) side) of high orders are assigned to the signal a for receivers, and 2 bits (high order (non-receipt at time of low C / N) side) of low order are assigned to the signal b for repeating installation. Consequently, the information (namely, the signal a for receivers) towards a receiver 25 serves as ability ready for receiving also at the time of low C / N.

[0034] In drawing 2 , the IFFT circuit 7 has a number equivalent to the number of the subcarriers

of a large number which constitute an OFDM signal of complex signal input sections (real part input section and imaginary part input section). By inputting into the corresponding input section the signal equivalent to the coordinate on I shown in drawing 5 (A) or this drawing (C) outputted from the mapping circuit 6, and the Gauss-Argand plane which consists of a Q-axis, and performing a complex inverse Fourier transform The input signal on a frequency shaft is changed into the complex signal on a time-axis (data symbol train). This complex signal is made into the OFDM signal of high frequency by supplying and carrying out quadrature modulation to the quadrature modulation machine 8.

[0035] After frequency conversion of the OFDM signal taken out from the hierarchy modulation circuit 3 is carried out to magnification and a transmit-frequencies band by the transmitted radio-frequency head 4 shown in drawing 1 , it is transmitted from aerial 5 as electric waves 21 and 22 to repeating installation 11 and a receiver 25.

[0036] In repeating installation 11, aerial 12 receives the electric wave 21 from a sending set 1, after extracting and amplifying the signal of a necessary frequency band by the received radio-frequency head 13, an OFDM recovery is carried out by the hierarchy demodulator circuit 14, and the hierarchized signal is separated. That is, the recovery output of the digital signal corresponding to [make the input signal on a frequency shaft output, when consider as the configuration which shows the hierarchy demodulator circuit 14 in the block diagram of drawing 3 , carry out the rectangular recovery of the input signal with the rectangular demodulator 18, the complex signal on a time-axis is obtained, that complex signal is supplied to the FFT circuit 19 and complex carries out a fast Fourier transform, supply this input signal to the distinction circuit 20 further, and / one by one] I and a Q-axis by the comparison with a threshold is carried out.

[0037] In repeating installation 11, when restoring to a non uniform 16QAM signal and the constellation of non uniform 16QAM is the subset of the constellation of 64QAM, it can distinguish with the same threshold as the usual 64QAM signal in the distinction circuit 20 as what takes eight steps of values at equal intervals in each shaft of the distinction as 64QAM, i.e., I and Q, respectively.

[0038] a retransmission of message of only the information on the signal b for repeating installation by the side of the high order among the information on non uniform 16QAM by which the hierarchy modulation was carried out in repeating installation 11 sake -- required -- low, since the information on the signal a for receivers of degree side is unnecessary Among the results of having distinguished the non uniform 16QAM signal, the information on a quadrant (2 bits of high orders shown in drawing 5 (A)) is thrown away, outputs only the information in a quadrant (2 bits of low order shown in drawing 5 (A)), and supplies it to the modulation circuit 15 of drawing 1 .

[0039] That is, the hierarchy demodulator circuit 14 is made as [output / only the signal for repeating installation assigned to the high order (non-receipt at time of low C / N) side by the hierarchy modulation circuit 3 of a sending set 1]. Since repeating installation 11 can be installed in the good place of receiving environments, such as the roof of a building, and a summit of a crest, and it can receive the electric wave 21 from a sending set 1 by C/N higher than a common receiver, also by the signal assigned to the high order (non-receipt at time of low C / N) side, it is fully mistaken and it can restore to it that there is nothing.

[0040] The output signal c of the hierarchy demodulator circuit 14, i.e., the signal for repeating installation, is supplied to a modulation circuit 15, and after [which is depended on QPSK here] an OFDM modulation is carried out, it is changed into the same frequency as the electric wave 21 from a sending set 1 by the transmitted radio-frequency head 16, and is transmitted from aerial 17 as an electric wave 23 to a receiver 25.

[0041] In a receiver 25, the electric wave 22 transmitted from the sending set 1 and the electric wave 23 transmitted from repeating installation 11 are received in aerial 24. The electric wave 22 transmitted from the sending set 1 is the OFDM signal with which each subcarrier was modulated by non uniform 16QAM and non uniform 16DAPSK including the information for repeating installation, on the other hand, the electric wave 23 transmitted from repeating installation 11 is the OFDM signal with which each subcarrier was modulated by QPSK, and

modulation techniques differ. however -- a receiver 25 -- the inside of electric waves 22 and 23 -- low, as what is necessary is just to be able to receive and only the signal of degree (it is ability ready for receiving also at the time of low C / N) side was mentioned above Since processing can be performed for the signal of non uniform 16QAM of an electric wave 22, or the signal of non uniform 16DAPSK as a signal of the same QPSK as an electric wave 23, A receiver 25 can restore to the signal with which both electric waves were received to coincidence, and both were compounded as a signal of QPSK.

[0042] Thus, according to the gestalt of this operation, since the thing of a sending set 1 and repeating installation 11 made in agreement [the timing of information transmission] is possible, when it is the same guard interval period as the former, distance of a sending set 1 and repeating installation 11 can be lengthened conventionally, and a service area can be expanded. Moreover, when the distance of a sending set 1 and repeating installation 11 is the same as the former, it becomes possible to shorten the period of the guard interval which is a redundant period, and the amount of information which this transmits can be increased.

[0043] Moreover, since he is trying to transmit the information which carried out the hierarchy modulation to repeating installation 11, the information towards repeating installation 11 can be superimposed on the signal turned to the receiving set 25 from the sending set 1, and the circuit of dedication can be made unnecessary.

[0044] Next, the gestalt of operation of the 2nd of the repeating installation which becomes this invention is explained. Drawing 6 (A) shows the block diagram of the gestalt of operation of the 2nd of the repeating installation which becomes this invention. The same sign is given to the same component as drawing 1 among this drawing, and the explanation is omitted. By adding a delay circuit 43 to the repeating installation 11 shown in drawing 1 , the repeating installation 41 of the gestalt of the 2nd operation shown in drawing 6 (A) presupposes that it is usable, when a relay point is plurality.

[0045] That is, although it is the example shown in drawing 1 in case the number of a transmitting point and relay points is one each for the gestalt of the 1st operation, two or more demands of the relay point may be carried out. Drawing 6 (C) shows the physical relationship established two places to the transmitting point 51, as a relay point shows by 52 and 53. In this case, the time delay which the radio wave propagation between the transmitting point 51 and a relay point 52 takes is t8, and the time delay which the radio wave propagation between the transmitting point 51 and a relay point 53 takes is t9, and, as for those time delays t8 and t9, also makes those distance not equal equally.

[0046] In such a case, the time delay of the delay circuit 2 shown in drawing 1 cannot be set to a meaning. Then, the repeating installation 41 of the gestalt of this 2nd operation is the repeating installation which enabled it to define at a meaning the time delay of the delay circuit 2 shown in drawing 1 in such a case. In using the repeating installation 41 shown in drawing 6 (A), it doubles with the time delay of the repeating installation with which the time delay of the sum total which added the time delay by signal processing of repeating installation to the time delay which the radio wave propagation between a relay point and a transmitting point takes the time delay of the delay circuit 2 shown in drawing 1 becomes max. Consequently, with repeating installation other than the repeating installation with which a time delay becomes max, a signal will be transmitted to timing earlier than a transmitting point.

[0047] In the repeating installation 41 shown in drawing 6 (A), in order to prevent a gap of this timing, a delay circuit 43 is established in the output of the hierarchy demodulator circuit 14, it is delayed and the output recovery signal of the hierarchy demodulator circuit 14 is supplied to a modulation circuit 15. The time delay of this delay circuit 43 is set as the difference of the time delay of the delay circuit 2 established in the sending set to the time delay of the sum total which added the time delay by signal processing of the repeating installation concerned to the time delay which the radio wave propagation between the relay points and the transmitting points that the repeating installation concerned is located takes. Thereby, the timing of a transmitting point and each relay point is in agreement.

[0048] For example, when it shall be t8 and time amount t3 shall be required in each of relay points 52 and 53 for junction processing, the time delay of the delay circuit 2 in the t9> sending

set 1 arranged at the transmitting point 51 is set as (t9+t3), and makes information transmit to the same timing substantially in drawing 6 (C) from the repeating installation of a relay point 53, and the sending set 1 of the transmitting point 51.
[0049] Furthermore, the time delay of the delay circuit 43 in the repeating installation 41 of a relay point 52 is set as (t9−t8) in this case. Thereby, the transmit timing of the sending set 1 arranged at the transmitting point 51 and the repeating installation 41 arranged at relay points 52 and 53, respectively is substantially in agreement. In addition, although both the repeating installation shown in drawing 1 by 11 and the repeating installation 41 of the repeating installation arranged at a relay point 53 shown in drawing 6 (A) are usable, in the case of repeating installation 41, the time delay of a delay circuit 43 is set as 0.
[0050] In addition, since a delay circuit 43 is a circuit which delays a digital signal, digital processing is possible for it. Specifically memory can be used, it can read with the write−in address, and a time delay can be defined according to the difference between addresses. Therefore, a setting change of a time delay can be made easily.
[0051] Next, the gestalt of operation of the 3rd of the repeating installation which becomes this invention is explained. Drawing 6 (B) shows the block diagram of the gestalt of operation of the 3rd of the repeating installation which becomes this invention. The same sign is given to the same component as drawing 1 among this drawing, and the explanation is omitted. By adding a delay circuit 47 to the repeating installation 11 shown in drawing 1 , like the gestalt of the 2nd operation, the repeating installation 45 of the gestalt of the 3rd operation shown in drawing 6 (B) presupposes that it is usable, when a relay point is plurality. However, with the gestalt of the 2nd operation, although the delay circuit 43 was established in the output side of the hierarchy demodulator circuit 14, as shown in drawing 6 (B), with the repeating installation 45 of the gestalt of this 3rd operation, the description is in the point of having established the delay circuit 47 in the input side of the hierarchy demodulator circuit 14.
[0052] Since the time delay of a delay circuit 47 and actuation are the same as that of it of the delay circuit 43 of the gestalt of the 2nd operation, explanation is omitted. This delay circuit 47 can consist of an analog and digital both. In digital processing, a time delay can be defined by the writing of memory, and address control of read−out like the gestalt of the 2nd operation. Moreover, in analog processing, since processing with a high frequency band is possible, although it is also possible to use the delay line by the well−known SAW (surface acoustic waves) component and the degree of freedom of a setup of a time delay is low in this case, it can miniaturize.
[0053] The relay system using the repeating installation 41 and 45 of the gestalt of the above−mentioned 2nd and the 3rd operation has the features of being applicable to a relay system with two or more relay points while having the same features as the gestalt of the 1st operation.
[0054]
[Effect of the Invention] Since each signal can be transmitted to coincidence towards both a receiver and repeating installation from the same transmitting section in a sending set according to this invention as explained above, the circuit for repeating installation can be made unnecessary.
[0055] According to this invention, the transmit timing of the signal to which it retransmits a message from repeating installation to a receiver, and the signal for receivers transmitted to a receiver from a sending set by moreover, the thing made mostly in agreement These signals write as the always same contents of information in a sending set and repeating installation. As compared with the conventional relay system, the time delay difference between the electric wave transmitted from the sending set in a receiver and the electric wave to which it retransmits a message from repeating installation is made to 1/2 or less. Therefore, in the case of the same guard interval period as the conventional relay system, distance of a sending set and repeating installation can be lengthened, and it can expand a service area.
[0056] Moreover, since the period of the guard interval which is a redundant period can be reduced, the amount of information to transmit can be made to increase conventionally by the case where the distance of a sending set and repeating installation is the same as the conventional relay system according to this invention.

[0057] Furthermore, the inside of the time amount which added the signal-processing time amount of two or more repeating installation arranged at each relay point in the information which should be transmitted at each radio-wave-propagation time amount from a transmitting point to two or more relay points of each when a sending set had two or more repeating installation according to this invention, It considers as the configuration set as the delay circuit by making the greatest time amount into a time delay. Repeating installation The transmitting time of day of a sending set, The signal to which the delay circuit for making mostly in agreement the time of day which self-equipment transmits is established in the input side or output side of a hierarchy demodulator circuit, and is broadcast again from two or more repeating installation to a receiver, Since it was made to make mostly in agreement the transmit timing of the signal for receivers transmitted to a receiver from a sending set, also in the relay system with which two or more repeating installation exists, the system which does not spoil each above-mentioned effectiveness can be built.

[0058] since [furthermore,] the electric wave from a sending set is receivable by C/N higher than a common receiver with the repeating installation which can be installed in the good place of receiving environments, such as the roof of a building, according to this invention -- the signal for receivers -- low -- degree side -- and the signal for receivers and the signal for repeating installation can carry out the reception recovery of said signal for repeating installation without an enough error by carrying out a hierarchy modulation at a high order side.

[0059] Furthermore, since it is SFN, this invention is compared with DFN, and its frequency use effectiveness is good, and it is fundamentally suitable also for migration reception.

[Translation done.]

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TECHNICAL FIELD

[Field of the Invention] This invention relates to the sending set and repeating installation which are used for the relay system and this to which the sending set and repeating installation which are used for a relay system and this are started, especially a receiver receives an orthogonal frequency division multiplex signal from both a sending set, and both [one side or].

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PRIOR ART

[Description of the Prior Art] As a modulation technique of ground digital broadcast, the orthogonal frequency division multiplex (OFDM) method is examined. An OFDM method can establish the redundant period called a guard interval, and has very strong resistance as compared with the digital broadcasting format of a single carrier method to the ghost (multi-pass) of the time delay within this guard interval period. For this reason, the junction by the single frequency called a single frequency network (SFN) is attained, and a receiver can receive the orthogonal frequency division multiplex signal of the same contents on the same frequency from both a sending set, and both [one side or].
[0003] Moreover, it is also possible to maintain a stable transmission condition to transmission and reception in the location to which this is used for and field strength, such as a building shadow, falls with the repeating installation (retransmission-of-message equipment) which uses the same frequency called a gap filler.

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EFFECT OF THE INVENTION

[Effect of the Invention] Since each signal can be transmitted to coincidence towards both a receiver and repeating installation from the same transmitting section in a sending set according to this invention as explained above, the circuit for repeating installation can be made unnecessary.
[0055] According to this invention, the transmit timing of the signal to which it retransmits a message from repeating installation to a receiver, and the signal for receivers transmitted to a receiver from a sending set by moreover, the thing made mostly in agreement These signals write as the always same contents of information in a sending set and repeating installation. As compared with the conventional relay system, the time delay difference between the electric wave transmitted from the sending set in a receiver and the electric wave to which it retransmits a message from repeating installation is made to 1/2 or less. Therefore, in the case of the same guard interval period as the conventional relay system, distance of a sending set and repeating installation can be lengthened, and it can expand a service area.
[0056] Moreover, since the period of the guard interval which is a redundant period can be reduced, the amount of information to transmit can be made to increase conventionally by the case where the distance of a sending set and repeating installation is the same as the conventional relay system according to this invention.
[0057] Furthermore, the inside of the time amount which added the signal-processing time amount of two or more repeating installation arranged at each relay point in the information which should be transmitted at each radio-wave-propagation time amount from a transmitting point to two or more relay points of each when a sending set had two or more repeating installation according to this invention, It considers as the configuration set as the delay circuit by making the greatest time amount into a time delay. Repeating installation The transmitting time of day of a sending set, The signal to which the delay circuit for making mostly in agreement the time of day which self-equipment transmits is established in the input side or output side of a hierarchy demodulator circuit, and is broadcast again from two or more repeating installation to a receiver, Since it was made to make mostly in agreement the transmit timing of the signal for receivers transmitted to a receiver from a sending set, also in the relay system with which two or more repeating installation exists, the system which does not spoil each above-mentioned effectiveness can be built.
[0058] since [furthermore,] the electric wave from a sending set is receivable by C/N higher than a common receiver with the repeating installation which can be installed in the good place of receiving environments, such as the roof of a building, according to this invention -- the signal for receivers -- low -- degree side -- and the signal for receivers and the signal for repeating installation can carry out the reception recovery of said signal for repeating installation without an enough error by carrying out a hierarchy modulation at a high order side.
[0059] Furthermore, since it is SFN, this invention is compared with DFN, and its frequency use effectiveness is good, and it is fundamentally suitable also for migration reception.

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TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] However, when acting as intermediary using a single frequency, in order for the repeating installation formed at a relay point to receive the electric wave of a sending set prepared in the transmitting point, to amplify it as it is and to broadcast it again, The signal to broadcast again becomes a thing with a time lag required for signal processing (magnification) of the repeating installation itself at the radio-wave-propagation time lag list between a transmitting point and a relay point. As a result of producing time difference between the electric wave transmitted from a sending set, and the electric wave to which it retransmits a message from repeating installation, a ghost's (multi-pass) time delay difference in a receiving point becomes large.
[0005] In a receiving point, that the time delay difference between the electric wave transmitted from a sending set and the electric wave to which it retransmits a message from repeating installation becomes the largest is the case where a receiving point is located on the straight line which ties a sending set and repeating installation, and see from a sending set and a receiving point is located in the direction where repeating installation is opposite. The time delay difference in this case becomes what added time amount required for signal processing (magnification) of the repeating installation itself the twice of the radio-wave-propagation time amount between a sending set and repeating installation.
[0006] In order to suppress such a time delay difference within the period of the guard interval of an OFDM signal, it is necessary to narrow distance of a sending set and repeating installation conventionally, or to lengthen the period of a guard interval. Moreover, in the above-mentioned conventional relay system, when the ghost (multi-pass) who has a time delay exceeding the period of a guard interval exists, the transmission quality deteriorates rapidly. On the other hand, a guard interval is a redundant period and lengthening this period causes the fall of transmission capacity.
[0007] On the other hand, the number network (DFN) of dual tone multifrequencies which uses two frequency bands conventionally is proposed (the collection of "examination of ground digital broadcast-2 cycle broadcast junction (DFN) by OFDM" 1995 television society annual meeting [besides Aiichiro Tsujiku] drafts, 277 pages - 278 pages). Since this DFN is a method which repeats two frequencies per program by turns, and uses them, deterioration of the transmission quality by the ghost is mitigated by adopting this DFN.
[0008] However, since this DFN uses two frequency bands, frequency use effectiveness is worse than SFN, and it is difficult effectiveness to use two frequency bands in the case of the junction of a program material. Furthermore, in DFN, an addressee needs to choose two frequency bands according to a receiving point, needs to receive, and is not suitable for migration reception.
[0009] This invention was made in view of the above point, and aims to let a sending set and repeating installation offer the sending set and repeating installation which are used for the relay system and this which can make small the time delay difference in the receiving point of the electric wave transmitted from a sending set, and the electric wave to which it retransmits a message from repeating installation in SFN using the same frequency.
[0010] Moreover, other purposes of this invention are to offer the sending set and repeating installation which are used for the relay system and this which shorten long-distance-izing of

the distance of a sending set and repeating installation, or the period of the guard interval which is a redundant period, and can enlarge transmission capacity.

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MEANS

[Means for Solving the Problem] In order to attain the above-mentioned purpose, the relay system of this invention After modulating the information which a sending set should transmit by the predetermined modulation technique, it transmits with predetermined frequency. The information which should modulate again and should be transmitted after repeating installation receives and restores to the electric wave which the sending set transmitted In the relay system which it retransmits a message [relay system] using the same frequency as a sending set, and makes the transmitted electric wave from both a sending set, and both [one side or] receive with a receiver a sending set While superimposing the signal for repeating installation for repeating installation to retransmit a message, and the signal for receivers for transmitting to a receiver directly by hierarchization, it becomes irregular and transmits to the 1st orthogonal frequency division multiplex signal. After repeating installation receives the electric wave which the sending set transmitted and carries out the separation recovery of the signal for repeating installation, it is characterized by becoming irregular again and retransmitting a message as 2nd orthogonal frequency division multiplex signal.
[0012] In this invention, since the signal for receivers turned to the receiver from the sending set is overlapped on the signal for repeating installation towards repeating installation, each signal can be transmitted to coincidence towards both a receiver and repeating installation from the same transmitting section in a sending set.
[0013] In order to attain the above-mentioned purpose, moreover, the sending set of this invention The information which should be transmitted with the delay circuit equivalent to the time amount of the sum of the radio-wave-propagation time amount from a transmitting point to a relay point, and the signal-processing time amount of repeating installation which carries out time delay and outputs the signal for receivers, and the signal for receivers The hierarchy modulation circuit which the information which is inputted into a delay circuit, and which should be transmitted is inputted as a signal for repeating installation, and assigns the signal for these receivers, and the signal for repeating installation to a bit different, respectively, hierarchizes them, and carries out an orthogonal frequency division multiplex modulation, It considers as the configuration which has the transmitting section which changes the output modulating signal of a hierarchy modulation circuit into a predetermined frequency band, and transmits.
[0014] The signal for receivers directly turned to the receiving point, without minding repeating installation among the signals transmitted from a sending set is the information for which only the time amount which added time amount required for signal processing (magnification, a recovery, second change tone) of the repeating installation itself to the radio-wave-propagation time amount between a transmitting point and a relay point from the sending set to the signal for repeating installation towards repeating installation was delayed by the delay circuit. For this reason, in this invention, the transmit timing of the signal for receivers transmitted to a receiver can be made mostly in agreement, and these signals serve as the always same contents of information from the signal to which it retransmits a message from repeating installation to a receiver, and a sending set in a sending set and repeating installation.
[0015] Consequently, in a receiver, when the time delay difference between the electric wave transmitted from a sending set and the electric wave to which it retransmits a message from

repeating installation becomes the largest, that time delay difference does not exceed the radio-wave-propagation time amount between a sending set and repeating installation. Therefore, as compared with the conventional relay system, 1/2 or less is the time delay difference between the electric wave transmitted from the sending set in a receiver, and the electric wave to which it retransmits a message from repeating installation.

[0016] Moreover, the inside of the time amount which added the signal-processing time amount of two or more repeating installation arranged at each relay point in the information which should be transmitted at each radio-wave-propagation time amount from a transmitting point to two or more relay points of each when a sending set had two or more repeating installation in this invention, Since it considers as the configuration set as the delay circuit by making the greatest time amount into a time delay and the delay circuit for repeating installation to make mostly in agreement the transmitting time of day of a sending set and the time of day which self-equipment transmits was established in the input side or output side of a hierarchy demodulator circuit, The transmit timing of the signal to which it retransmits a message from two or more repeating installation to a receiver, and the signal for receivers transmitted to a receiver from a sending set can be made mostly in agreement.

[0017] furthermore -- this invention -- a hierarchy modulation circuit -- the signal for receivers -- low -- degree side -- and although the signal for repeating installation is written as the configuration which carries out a hierarchy modulation at a high order side and receiving station important point C/N in repeating installation becomes high, the electric wave from a sending set is receivable by C/N higher than a common receiver with the repeating installation which can be installed in the good place of receiving environments, such as the roof of a building.

[0018]

[Embodiment of the Invention] Next, the gestalt of operation of this invention is explained with a drawing.

[0019] Drawing 1 shows the block diagram of the gestalt of operation of the 1st of the sending set used for the relay system and this which become this invention, and repeating installation. The relay system of the gestalt of this operation has the description in the point that a sending set 1 and repeating installation 11 transmit the OFDM signal of the same contents on the same frequency, a receiver 25 is the method which receives that OFDM signal, a sending set 1 has the hierarchy modulation circuit 3, and repeating installation 11 has the hierarchy demodulator circuit 14.

[0020] It consists of the transmitted high-frequency sections 4 which a sending set 1 carries out frequency conversion of the output signal of the delay circuit 2 delayed in the information which should be transmitted, the hierarchy modulation circuit 3 which the information to which the output signal of this delay circuit 2 should transmit as a signal a for receivers is inputted as a signal b for repeating installation, respectively, hierarchizes these signals, and carries out an OFDM modulation, and the hierarchy modulation circuit 3 to magnification and the transmitting band of a RF, and transmit through aerial 5. in addition -- the hierarchy modulation circuit 3 -- the signal a for receivers -- low -- the signal b for repeating installation carries out a hierarchy modulation at a high order (non-receipt at time of low C / N) side at degree (it is ability ready for receiving also at the time of a low carrier power pair noise power ratio (C/N)) side. The hierarchy modulation circuit 3 consists of a mapping circuit 6, and the reverse fast-Fourier-transform (IFFT) circuit 7 and the quadrature modulation circuit 8, as shown in the block diagram of drawing 2 .

[0021] The aerial 12 where repeating installation 11 receives the electric wave 21 from a sending set 1, The received radio-frequency head 13 which extracts the signal of a necessary frequency band and is amplified from the input signal from aerial 12, The hierarchy demodulator circuit 14 which carries out the OFDM recovery of the received RF signal from the received radio-frequency head 13, separates the hierarchized signal, and acquires the signal c for repeating installation which is a signal by the side of a high order further, It consists of aerial 17 which transmits the output RF signal of the modulation circuit 15 which carries out the OFDM modulation of the signal c for repeating installation, the transmitted radio-frequency head 16 which changes the output OFDM signal of a modulation circuit 15 into magnification and a high-

frequency band, and the transmitted radio-frequency head 16 as an electric wave 23. The hierarchy demodulator circuit 14 consists of a rectangular demodulator 18, a fast-Fourier-transform (FFT) circuit 19, and a distinction circuit 20, as shown in the block diagram of drawing 3 .

[0022] In addition, let the frequency of the electric wave 23 transmitted from aerial 17 be the same frequency as the electric waves 21 and 22 from a sending set 1. Moreover, a receiver 25 restores to the electric wave 22 transmitted from the sending set 1, and the electric wave 23 transmitted from repeating installation 11 after reception in aerial 24.

[0023] Next, drawing 4 and drawing 5 are combined and referred to about actuation of the gestalt of this operation, and it explains to a detail. Drawing 4 (A) is drawing showing the physical relationship of the transmitting point 31 that the sending set 1 was installed, the relay point 32 when repeating installation 11 was installed, and the receiving point 33 which is the location of a receiver 25. t1, t2, and t4 show the time delay which the radio wave propagation between the transmitting point 31, between the receiving points 33 and the transmitting point 31, and a relay point 32 and between a relay point 32 and the receiving point 33 takes, respectively, and t3 shows the processing time in the repeating installation 11 installed at the relay point 32, i.e., a time delay required for retransmission of message.

[0024] At the receiving point 33, the electric wave 34 sent from the transmitting point 31 and the electric wave 36 sent from a relay point 32 are received to coincidence. Supposing the repeating installation 11 installed at the relay point 32 only amplifies the electric wave 35 sent from the transmitting point 31 and broadcasts it again now, while the electric wave 34 sent from the transmitting point 31, and the electric wave 36 sent from a relay point 32 (t2+t3+t4-t1), a time delay difference will be produced at the receiving point 33.

[0025] Drawing 4 (B) is drawing showing the time relation in the receiving point 33 of the signal 37 of the electric wave 34 at this time, and the signal 38 of an electric wave 36. Although signals 37 and 38 are signals of the same contents, the time delay difference t5 is produced. This time delay difference t5 is said time delay difference (t2+t3+t4-t1). Each signal 37 and 38 constitutes one symbol from information d1 and a guard interval d2. In an OFDM recovery, the period of the die length equivalent to the part of information d1 is extracted from the period of the arbitration within this 1 symbol period.

[0026] In drawing 4 (B), the recovery section t6 is equivalent to this. However, the time delay difference t5 of a signal 37 and a signal 38 is large, and when a signal 37 and a signal 38 are compounded, the symbol interference section t7 is produced. In this symbol interference section t7, since a symbol with different information is compounded, an error is produced to original information after a recovery. That is, when the time delay difference t5 is longer than the period of the guard interval d2, the symbol interference section t7 which is equivalent to the time difference at least is produced, and an error is produced.

[0027] The gestalt of this operation sets the time delay difference t5 to (t4-t1) by compensating the time delay which is equivalent to a sending set 1 and repeating installation 11 showing to drawing 4 (A) (t2+t3) for the purpose of not producing this symbol interference section. Drawing 4 (C) shows the time relation in the receiving point 33 of the signal 37 of the electric wave 34 at this time, and the signal 38 of an electric wave 36. As shown in this drawing, the time delay difference t5 is shorter than the period of the guard interval d2, and does not produce the symbol interference section.

[0028] Next, a hierarchy modulation is explained with drawing 5 . Drawing 5 (A) shows the constellation of non uniform 16QAM (quadrature amplitude modulation), and four digits in drawing show the 4-bit sign assigned to each signal point. 2 bits of high orders of several characters each support the quadrant in which each signal point is located, and 2 bits of low order support the location of the signal point in each quadrant. Although the distance of each sign is large and transmission with low [C/N] is possible about 2 bits of high orders, about 2 bits of low order, the distance of each sign is small and C/high N is required as compared with 2 bits of high orders. therefore -- low -- a hierarchy modulation is attained by assigning the information on degree (it being ability ready for receiving also at the time of low C / N) side to 2 bits of high orders, and assigning the information by the side of a high order (non-receipt at the time of low

C / N) to 2 bits of low order.
[0029] Moreover, about 2 bits of high orders, the same figure as the constellation of QPSK (4 phase phase modulation) shown in drawing 5 (B) is assigned. therefore, the inside of the signal of non uniform 16QAM shown in drawing 5 (A) -- low -- when what is necessary is to be able to receive only the signal of degree (it is ability ready for receiving also at the time of low C / N) side, it can process as a signal of QPSK which shows the signal of non uniform 16QAM to drawing 5 (B).
[0030] Drawing 5 (C) shows the constellation of non uniform 16DAPSK (differential amplitude phase modulation). Four digits in drawing show the 4-bit sign assigned to each signal point. Also in this case, as well as non uniform 16QAM, 2 bits of high orders support the quadrant in which each signal point is located, and 2 bits of low order support the location of the signal point in each quadrant. therefore --the same -- low -- when what is necessary is to be able to receive only the signal of degree (it is ability ready for receiving also at the time of low C / N) side, it can process as a signal of QPSK which shows the signal of non uniform 16DAPSK to drawing 5 (B).
[0031] Information which should be transmitted in a sending set 1 for returning to drawing 1 again and explaining actuation is carried out 2 ****s, and predetermined time delay of one side is carried out by the delay circuit 2. Let this time delay be the time amount adding the time amount (t3 of drawing 4 (A)) which signal processing of repeating installation 11 takes at the time amount (t2 of drawing 4 (A)) to which an electric wave 21 spreads between a sending set 1 and repeating installation 11. Therefore, in the example shown in drawing 4 (A), this time delay is set as (t2+t3), and sets the time delay difference t5 to (t4-t1). The signal delayed by the delay circuit 2 turns into the signal a for receivers. By defining the time delay of a delay circuit 2 in this way, information can be transmitted from a sending set 1 and repeating installation 11 to the same timing.
[0032] Another side of the information which was distributed two times and which should be transmitted is directly supplied to the hierarchy modulation circuit 3 as a signal b for repeating installation. The hierarchy modulation circuit 3 receives the above-mentioned signal b for repeating installation, and the signal a for receivers from a delay circuit 3 as an input signal, and after hierarchizing these, it performs an OFDM modulation. Namely, while the data is assigned to each subcarrier which constitutes an OFDM signal in the mapping circuit 6, the signal a for receivers which the hierarchy modulation circuit 3 is considered as the configuration shown in the block diagram of drawing 2 , and was inputted, and the signal b for repeating installation the I [which is shown in drawing 5 (A) or drawing 5 (C)], and Gauss-Argand plane top which consists of a Q-axis -- the signal a for receivers, and the signal b for repeating installation -- respectively -- low -- it hierarchizes by being arranged at a degree and high order side.
[0033] here, non uniform 16DAPSK of the constellation shown in non uniform 16QAM and this drawing (C) of the constellation shown in drawing 5 (A) is used for hierarchization, 2 bits (low -- degree (ready for receiving also at the time of low C / N) side) of high orders are assigned to the signal a for receivers, and 2 bits (high order (non-receipt at time of low C / N) side) of low order are assigned to the signal b for repeating installation. Consequently, the information (namely, the signal a for receivers) towards a receiver 25 serves as ability ready for receiving also at the time of low C / N.
[0034] In drawing 2 , the IFFT circuit 7 has a number equivalent to the number of the subcarriers of a large number which constitute an OFDM signal of complex signal input sections (real part input section and imaginary part input section). By inputting into the corresponding input section the signal equivalent to the coordinate on I shown in drawing 5 (A) or this drawing (C) outputted from the mapping circuit 6, and the Gauss-Argand plane which consists of a Q-axis, and performing a complex inverse Fourier transform The input signal on a frequency shaft is changed into the complex signal on a time-axis (data symbol train). This complex signal is made into the OFDM signal of high frequency by supplying and carrying out quadrature modulation to the quadrature modulation machine 8.
[0035] After frequency conversion of the OFDM signal taken out from the hierarchy modulation circuit 3 is carried out to magnification and a transmit-frequencies band by the transmitted

radio-frequency head 4 shown in drawing 1 , it is transmitted from aerial 5 as electric waves 21 and 22 to repeating installation 11 and a receiver 25.

[0036] In repeating installation 11, aerial 12 receives the electric wave 21 from a sending set 1, after extracting and amplifying the signal of a necessary frequency band by the received radio-frequency head 13, an OFDM recovery is carried out by the hierarchy demodulator circuit 14, and the hierarchized signal is separated. That is, the recovery output of the digital signal corresponding to [make the input signal on a frequency shaft output, when consider as the configuration which shows the hierarchy demodulator circuit 14 in the block diagram of drawing 3 , carry out the rectangular recovery of the input signal with the rectangular demodulator 18, the complex signal on a time-axis is obtained, that complex signal is supplied to the FFT circuit 19 and complex carries out a fast Fourier transform, supply this input signal to the distinction circuit 20 further, and / one by one] I and a Q-axis by the comparison with a threshold is carried out.

[0037] In repeating installation 11, when restoring to a non uniform 16QAM signal and the constellation of non uniform 16QAM is the subset of the constellation of 64QAM, it can distinguish with the same threshold as the usual 64QAM signal in the distinction circuit 20 as what takes eight steps of values at equal intervals in each shaft of the distinction as 64QAM, i.e., I and Q, respectively.

[0038] a retransmission of message of only the information on the signal b for repeating installation by the side of the high order among the information on non uniform 16QAM by which the hierarchy modulation was carried out in repeating installation 11 sake -- required -- low, since the information on the signal a for receivers of degree side is unnecessary Among the results of having distinguished the non uniform 16QAM signal, the information on a quadrant (2 bits of high orders shown in drawing 5 (A)) is thrown away, outputs only the information in a quadrant (2 bits of low order shown in drawing 5 (A)), and supplies it to the modulation circuit 15 of drawing 1 .

[0039] That is, the hierarchy demodulator circuit 14 is made as [output / only the signal for repeating installation assigned to the high order (non-receipt at time of low C / N) side by the hierarchy modulation circuit 3 of a sending set 1]. Since repeating installation 11 can be installed in the good place of receiving environments, such as the roof of a building, and a summit of a crest, and it can receive the electric wave 21 from a sending set 1 by C/N higher than a common receiver, also by the signal assigned to the high order (non-receipt at time of low C / N) side, it is fully mistaken and it can restore to it that there is nothing.

[0040] The output signal c of the hierarchy demodulator circuit 14, i.e., the signal for repeating installation, is supplied to a modulation circuit 15, and after [which is depended on QPSK here] an OFDM modulation is carried out, it is changed into the same frequency as the electric wave 21 from a sending set 1 by the transmitted radio-frequency head 16, and is transmitted from aerial 17 as an electric wave 23 to a receiver 25.

[0041] In a receiver 25, the electric wave 22 transmitted from the sending set 1 and the electric wave 23 transmitted from repeating installation 11 are received in aerial 24. The electric wave 22 transmitted from the sending set 1 is the OFDM signal with which each subcarrier was modulated by non uniform 16QAM and non uniform 16DAPSK including the information for repeating installation, on the other hand, the electric wave 23 transmitted from repeating installation 11 is the OFDM signal with which each subcarrier was modulated by QPSK, and modulation techniques differ. however -- a receiver 25 -- the inside of electric waves 22 and 23 -- low, as what is necessary is just to be able to receive and only the signal of degree (it is ability ready for receiving also at the time of low C / N) side was mentioned above Since processing can be performed for the signal of non uniform 16QAM of an electric wave 22, or the signal of non uniform 16DAPSK as a signal of the same QPSK as an electric wave 23, A receiver 25 can restore to the signal with which both electric waves were received to coincidence, and both were compounded as a signal of QPSK.

[0042] Thus, according to the gestalt of this operation, since the thing of a sending set 1 and repeating installation 11 made in agreement [the timing of information transmission] is possible, when it is the same guard interval period as the former, distance of a sending set 1 and

repeating installation 11 can be lengthened conventionally, and a service area can be expanded. Moreover, when the distance of a sending set 1 and repeating installation 11 is the same as the former, it becomes possible to shorten the period of the guard interval which is a redundant period, and the amount of information which this transmits can be increased.

[0043] Moreover, since he is trying to transmit the information which carried out the hierarchy modulation to repeating installation 11, the information towards repeating installation 11 can be superimposed on the signal turned to the receiving set 25 from the sending set 1, and the circuit of dedication can be made unnecessary.

[0044] Next, the gestalt of operation of the 2nd of the repeating installation which becomes this invention is explained. Drawing 6 (A) shows the block diagram of the gestalt of operation of the 2nd of the repeating installation which becomes this invention. The same sign is given to the same component as drawing 1 among this drawing, and the explanation is omitted. By adding a delay circuit 43 to the repeating installation 11 shown in drawing 1 , the repeating installation 41 of the gestalt of the 2nd operation shown in drawing 6 (A) presupposes that it is usable, when a relay point is plurality.

[0045] That is, although it is the example shown in drawing 1 in case the number of a transmitting point and relay points is one each for the gestalt of the 1st operation, two or more demands of the relay point may be carried out. Drawing 6 (C) shows the physical relationship established two places to the transmitting point 51, as a relay point shows by 52 and 53. In this case, the time delay which the radio wave propagation between the transmitting point 51 and a relay point 52 takes is t8, and the time delay which the radio wave propagation between the transmitting point 51 and a relay point 53 takes is t9, and, as for those time delays t8 and t9, also makes those distance not equal equally.

[0046] In such a case, the time delay of the delay circuit 2 shown in drawing 1 cannot be set to a meaning. Then, the repeating installation 41 of the gestalt of this 2nd operation is the repeating installation which enabled it to define at a meaning the time delay of the delay circuit 2 shown in drawing 1 in such a case. In using the repeating installation 41 shown in drawing 6 (A), it doubles with the time delay of the repeating installation with which the time delay of the sum total which added the time delay by signal processing of repeating installation to the time delay which the radio wave propagation between a relay point and a transmitting point takes the time delay of the delay circuit 2 shown in drawing 1 becomes max. Consequently, with repeating installation other than the repeating installation with which a time delay becomes max, a signal will be transmitted to timing earlier than a transmitting point.

[0047] In the repeating installation 41 shown in drawing 6 (A), in order to prevent a gap of this timing, a delay circuit 43 is established in the output of the hierarchy demodulator circuit 14, it is delayed and the output recovery signal of the hierarchy demodulator circuit 14 is supplied to a modulation circuit 15. The time delay of this delay circuit 43 is set as the difference of the time delay of the delay circuit 2 established in the sending set to the time delay of the sum total which added the time delay by signal processing of the repeating installation concerned to the time delay which the radio wave propagation between the relay points and the transmitting points that the repeating installation concerned is located takes. Thereby, the timing of a transmitting point and each relay point is in agreement.

[0048] For example, when it shall be t8 and time amount t3 shall be required in each of relay points 52 and 53 for junction processing, the time delay of the delay circuit 2 in the t9> sending set 1 arranged at the transmitting point 51 is set as (t9+t3), and makes information transmit to the same timing substantially in drawing 6 (C) from the repeating installation of a relay point 53, and the sending set 1 of the transmitting point 51.

[0049] Furthermore, the time delay of the delay circuit 43 in the repeating installation 41 of a relay point 52 is set as (t9−t8) in this case. Thereby, the transmit timing of the sending set 1 arranged at the transmitting point 51 and the repeating installation 41 arranged at relay points 52 and 53, respectively is substantially in agreement. In addition, although both the repeating installation shown in drawing 1 by 11 and the repeating installation 41 of the repeating installation arranged at a relay point 53 shown in drawing 6 (A) are usable, in the case of repeating installation 41, the time delay of a delay circuit 43 is set as 0.

[0050] In addition, since a delay circuit 43 is a circuit which delays a digital signal, digital processing is possible for it. Specifically memory can be used, it can read with the write-in address, and a time delay can be defined according to the difference between addresses. Therefore, a setting change of a time delay can be made easily.

[0051] Next, the gestalt of operation of the 3rd of the repeating installation which becomes this invention is explained. Drawing 6 (B) shows the block diagram of the gestalt of operation of the 3rd of the repeating installation which becomes this invention. The same sign is given to the same component as drawing 1 among this drawing, and the explanation is omitted. By adding a delay circuit 47 to the repeating installation 11 shown in drawing 1 , like the gestalt of the 2nd operation, the repeating installation 45 of the gestalt of the 3rd operation shown in drawing 6 (B) presupposes that it is usable, when a relay point is plurality. However, with the gestalt of the 2nd operation, although the delay circuit 43 was established in the output side of the hierarchy demodulator circuit 14, as shown in drawing 6 (B), with the repeating installation 45 of the gestalt of this 3rd operation, the description is in the point of having established the delay circuit 47 in the input side of the hierarchy demodulator circuit 14.

[0052] Since the time delay of a delay circuit 47 and actuation are the same as that of it of the delay circuit 43 of the gestalt of the 2nd operation, explanation is omitted. This delay circuit 47 can consist of an analog and digital both. In digital processing, a time delay can be defined by the writing of memory, and address control of read-out like the gestalt of the 2nd operation. Moreover, in analog processing, since processing with a high frequency band is possible, although it is also possible to use the delay line by the well-known SAW (surface acoustic waves) component and the degree of freedom of a setup of a time delay is low in this case, it can miniaturize.

[0053] The relay system using the repeating installation 41 and 45 of the gestalt of the above-mentioned 2nd and the 3rd operation has the features of being applicable to a relay system with two or more relay points while having the same features as the gestalt of the 1st operation.

[Translation done.]

* NOTICES *

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2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the block diagram of the gestalt of operation of the 1st of this invention.
[Drawing 2] It is the block diagram of an example of the hierarchy modulation circuit in drawing 1.
[Drawing 3] It is the block diagram of an example of the hierarchy demodulator circuit in drawing 1.
[Drawing 4] It is the explanatory view of the physical relationship of the transmitting point in a relay system, a relay point, and a receiving point, and the time relation of a signal.
[Drawing 5] It is a constellation Fig. explaining the hierarchy modulation circuit in drawing 1.
[Drawing 6] They are the block diagram of the gestalt of the 2nd and operation of the 3rd of the repeating installation of this invention, and explanatory views, such as radio-wave-propagation time amount of a transmitting point and a relay point.
[Description of Notations]
1 Sending Set
2 Delay Circuit
3 Hierarchy Modulation Circuit
4 Transmitted Radio-frequency Head
6 Mapping Circuit
7 Reverse Fast-Fourier-Transform (IFFT) Circuit
8 Quadrature Modulation Machine
11, 41, 45 Repeating installation
13 Received Radio-frequency Head
14 Hierarchy Demodulator Circuit
15 Modulation Circuit
16 Transmitted Radio-frequency Head
18 Rectangular Demodulator
19 Fast-Fourier-Transform (FFT) Circuit
20 Distinction Circuit
21-23 Electric wave
25 Receiver
31 51 Transmitting point
32, 52, 53 Relay point
33 Receiving Point
43 47 Delay circuit
The signal for receivers
b, c Signal for repeating installation
d1 Information
d2 Guard interval

[Translation done.]

引用文献３

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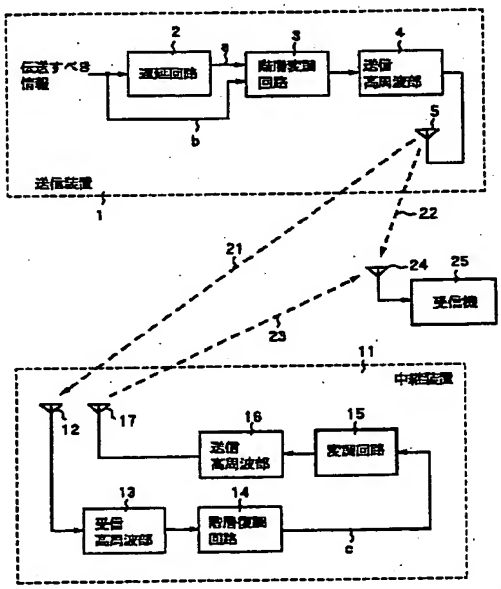
(54)【発明の名称】　中継方式及びこれに用いる送信装置及び中継装置

(57)【要約】
【課題】　遅延時間差をＯＦＤＭ信号のガードインターバルの期間内に抑えるためには、従来は送信装置と中継装置との距離を狭くするか、又はガードインターバルの期間を長くする必要がある。二周波数ネットワークは周波数利用効率がＳＦＮよりも悪く、また、移動受信には適さない。
【解決手段】　送信装置１において、伝送すべき情報は遅延回路２により、送信装置１と中継装置１１との間を電波２１が伝搬する時間に、中継装置１１の信号処理に要する時間を加算した時間とする。階層変調回路３は受信機用信号ａには上位２ビット（低次（低Ｃ／Ｎ時も受信可）側）を割り当て、中継装置用信号ｂには下位２ビット（高次（低Ｃ／Ｎ時には受信不能）側）を割り当てて階層化してから、ＯＦＤＭ変調する。中継装置１１においては、階層復調回路１４によりＯＦＤＭ復調し、高次側に割り当てられた中継装置用信号のみを出力する。

本発明の第１の実施の形態のブロック図



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【特許請求の範囲】

【請求項１】　送信装置が伝送すべき情報を所定の変調方式で変調した後所定周波数で送信し、中継装置が前記送信装置が送信した電波を受信及び復調した後再度変調して前記伝送すべき情報を、前記送信装置と同一周波数を用いて再送信し、受信機により前記送信装置及び中継装置の一方又は両方からの送信電波を受信させる中継方式において、

前記送信装置は、前記中継装置が再送信するための中継装置用信号と、前記受信機へ直接送信するための受信機用信号とを階層化により重畳すると共に第１の直交周波数分割多重信号に変調して送信し、前記中継装置は、前記送信装置が送信した電波を受信して前記中継装置用信号を分離復調した後再度変調して第２の直交周波数分割多重信号として再送信することを特徴とする中継方式。

【請求項２】　伝送すべき情報を送信点から中継点までの電波伝搬時間と前記中継装置の信号処理時間との和の時間に相当する時間遅延して受信機用信号を出力する遅延回路と、

該受信機用信号と共に、前記遅延回路に入力される前記伝送すべき情報を中継装置用信号として入力され、これら受信機用信号と中継装置用信号とをそれぞれ異なるビットに割り当てて階層化し直交周波数分割多重変調する階層変調回路と、

該階層変調回路の出力変調信号を所定周波数帯に変換して送信する送信部とを有することを特徴とする請求項１記載の中継方式に用いる送信装置。

【請求項３】　前記中継装置が複数ある場合に、伝送すべき情報を送信点から複数の各中継点までのそれぞれの電波伝搬時間に該各中継点に配置されている前記複数の中継装置の信号処理時間を加えた時間のうち、最大の時間を遅延時間として前記遅延回路に設定したことを特徴とする請求項２記載の送信装置。

【請求項４】　前記階層変調回路は、前記受信機用信号は低次側に、かつ、前記中継装置用信号は高次側に階層化することを特徴とする請求項２又は３記載の送信装置。

【請求項５】　前記階層変調回路は、ノンユニフォーム１６ＱＡＭ又はノンユニフォーム１６ＤＡＰＳＫにより階層化を行い、複数の搬送波のそれぞれが該ノンユニフォーム１６ＱＡＭ又はノンユニフォーム１６ＤＡＰＳＫで変調された直交周波数分割多重信号を出力することを特徴とする請求項２又は３記載の送信装置。

【請求項６】　前記送信装置が送信した電波を受信する受信部と、

該受信部が受信した信号から前記中継装置用信号を復調する階層復調回路と、

復調された該中継装置用信号を所定の変調方式で変調した直交周波数分割多重信号を出力する変調回路と、

該変調回路の出力信号を前記送信装置と同一周波数帯に

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変換して送信する送信部とを有することを特徴とする請求項１記載の中継方式に用いる中継装置。

【請求項７】　前記送信装置の送信時刻と、自装置が送信する時刻とをほぼ一致させるための遅延回路を、前記階層復調回路の入力側又は出力側に設けたことを特徴とする請求項６記載の中継装置。

【請求項８】　前記変調回路は、複数の搬送波のそれぞれが前記中継装置用信号でＱＰＳＫ変調された直交周波数分割多重を生成出力することを特徴とする請求項５又は６記載の中継装置。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は中継方式及びこれに用いる送信装置及び中継装置に係り、特に受信機が送信装置及び中継装置の一方又は両方から直交周波数分割多重信号を受信する中継方式及びこれに用いる送信装置及び中継装置に関する。

【０００２】

【従来の技術】地上ディジタル放送の変調方式として、直交周波数分割多重（ＯＦＤＭ）方式が検討されている。ＯＦＤＭ方式は、ガードインターバルと呼ばれる冗長な期間を設けることが可能であり、このガードインターバル期間内の遅延時間のゴースト（マルチパス）に対して、シングルキャリア方式のディジタル放送方式に比較して非常に強い耐性を有している。このため、単一周波数ネットワーク（ＳＦＮ）と呼ばれる単一周波数による中継が可能となり、受信機は送信装置及び中継装置の一方又は両方から同一周波数で同一内容の直交周波数分割多重信号を受信することができる。

【０００３】また、このことを利用し、ビル影等の電界強度が低下する場所での送受信に対して、ギャップフィラーと呼ばれる同一周波数を使用する中継装置（再送信装置）により安定な伝送状態を維持することも可能である。

【０００４】

【発明が解決しようとする課題】しかしながら、単一の周波数を用いて中継を行う場合、中継点に設けられる中継装置は送信点に設けられた送信装置の電波を受信し、そのまま増幅して再送信するため、再送信する信号が、送信点と中継点との間の電波伝搬時間の遅れ並びに中継装置自体の信号処理（増幅）に必要な時間の遅れを有したものとなり、送信装置から送信される電波と中継装置から再送信される電波との間に時間差を生ずる結果、受信点におけるゴースト（マルチパス）の遅延時間差が大きくなる。

【０００５】受信点において、送信装置から送信される電波と中継装置から再送信される電波との間の遅延時間差が最も大きくなるのは、送信装置と中継装置とを結ぶ直線上に受信点が位置し、かつ、送信装置から見て中継装置とは反対の方向に受信点が位置する場合である。こ

の場合の遅延時間差は、送信装置と中継装置との間の電波伝搬時間の２倍に中継装置自体の信号処理（増幅）に必要な時間を加えたものとなる。

【０００６】このような遅延時間差をＯＦＤＭ信号のガードインターバルの期間内に抑えるためには、従来は送信装置と中継装置との距離を狭くするか、又はガードインターバルの期間を長くする必要がある。また、上記の従来の中継方式では、ガードインターバルの期間を越える遅延時間を有するゴースト（マルチパス）が存在する場合には、急激に伝送品質が劣化する。一方、ガードインターバルは冗長な期間であり、この期間を長くすることは伝送容量の低下を招く。

【０００７】一方、従来より二つの周波数帯域を使用する二周波数ネットワーク（ＤＦＮ）が提案されている（都竹愛一郎他、「ＯＦＤＭによる地上ディジタル放送－二周波放送中継（ＤＦＮ）の検討」、１９９５年テレビジョン学会年次大会予稿集、２７７頁～２７８頁）。このＤＦＮは、１番組当り二つの周波数を交互に繰り返し用いる方式であるため、このＤＦＮを採用することにより、ゴーストによる伝送品質の低下が軽減される。

【０００８】しかしながら、このＤＦＮは二つの周波数帯を使用することから、周波数利用効率がＳＦＮよりも悪く、また、番組素材の中継の場合には二つの周波数帯を使用することは困難である。更に、ＤＦＮでは受信者が二つの周波数帯を受信点に応じて選択して受信する必要があり、移動受信には適さない。

【０００９】本発明は以上の点に鑑みなされたもので、送信装置と中継装置が同一の周波数を用いるＳＦＮにおいて、送信装置から送信される電波と中継装置から再送信される電波の受信点での遅延時間差を小さくし得る中継方式及びこれに用いる送信装置及び中継装置を提供することを目的とする。

【００１０】また、本発明の他の目的は、送信装置と中継装置の距離の長距離化あるいは、冗長な期間であるガードインターバルの期間を短くして伝送容量を大きくし得る中継方式及びこれに用いる送信装置及び中継装置を提供することにある。

【００１１】

【課題を解決するための手段】上記の目的を達成するため、本発明の中継方式は、送信装置が伝送すべき情報を所定の変調方式で変調した後所定周波数で送信し、中継装置が送信装置が送信した電波を受信及び復調した後再度変調して伝送すべき情報を、送信装置と同一周波数を用いて再送信し、受信機により送信装置及び中継装置の一方又は両方からの送信電波を受信させる中継方式において、送信装置は、中継装置が再送信するための中継装置用信号と、受信機へ直接送信するための受信機用信号とを階層化により重畳すると共に第１の直交周波数分割多重信号に変調して送信し、中継装置は、送信装置が送信した電波を受信して中継装置用信号を分離復調した後

再度変調して第２の直交周波数分割多重信号として再送信することを特徴とする。

【００１２】この発明では、中継装置へ向けた中継装置用信号が、送信装置から受信機へ向けた受信機用信号に重畳されているため、送信装置内の同一の送信部から受信機と中継装置の両方にむけてそれぞれの信号を同時に送信することができる。

【００１３】また、上記の目的を達成するため、本発明の送信装置は、伝送すべき情報を送信点から中継点までの電波伝搬時間と中継装置の信号処理時間との和の時間に相当する時間遅延して受信機用信号を出力する遅延回路と、受信機用信号と共に、遅延回路に入力される伝送すべき情報を中継装置用信号として入力され、これら受信機用信号と中継装置用信号とをそれぞれ異なるビットに割り当てて階層化し直交周波数分割多重変調する階層変調回路と、階層変調回路の出力変調信号を所定周波数帯に変換して送信する送信部とを有する構成としたものである。

【００１４】送信装置から送信する信号のうち、中継装置を介さずに直接に受信点に向けた受信機用信号は、送信装置から中継装置へ向けた中継装置用信号に対して送信点と中継点との間の電波伝搬時間に、中継装置自体の信号処理（増幅、復調、再変調）に必要な時間を加えた時間だけ遅延回路により遅延された情報である。このため、本発明では、中継装置から受信機へ再送信される信号と、送信装置から受信機へ送信される受信機用信号の送信タイミングをほぼ一致させることができ、これらの信号は送信装置と中継装置において常に同じ情報内容となる。

【００１５】この結果、受信機において、送信装置から送信される電波と中継装置から再送信される電波との間の遅延時間差が最も大きくなる場合においても、その遅延時間差は送信装置と中継装置との間の電波伝搬時間を越えることはない。従って、従来の中継方式に比較し、受信機における送信装置から送信される電波と中継装置から再送信される電波との間の遅延時間差は２分の１以下になる。

【００１６】また、本発明では送信装置は中継装置が複数ある場合に、伝送すべき情報を送信点から複数の各中継点までのそれぞれの電波伝搬時間に各中継点に配置されている複数の中継装置の信号処理時間を加えた時間のうち、最大の時間を遅延時間として遅延回路に設定した構成とし、中継装置は送信装置の送信時刻と、自装置が送信する時刻とをほぼ一致させるための遅延回路を、階層復調回路の入力側又は出力側に設けるようにしたため、複数の中継装置から受信機へ再送信される信号と、送信装置から受信機へ送信される受信機用信号の送信タイミングをほぼ一致させることができる。

【００１７】更に、本発明では階層変調回路が、受信機用信号は低次側に、かつ、中継装置用信号は高次側に階

層変調する構成としたため、中継装置における受信所要Ｃ／Ｎは高くなるが、ビルの屋上などの受信環境の良い所に設置することが可能な中継装置では、一般の受信機よりも高いＣ／Ｎで送信装置からの電波を受信できる。

【００１８】

【発明の実施の形態】次に、本発明の実施の形態について図面と共に説明する。

【００１９】図１は本発明になる中継方式及びこれに用いる送信装置及び中継装置の第１の実施の形態のブロック図を示す。この実施の形態の中継方式は、送信装置１と中継装置１１が同一周波数で同一内容のＯＦＤＭ信号を送信し、受信機２５がそのＯＦＤＭ信号を受信する方式であり、送信装置１が階層変調回路３を有し、中継装置１１が階層復調回路１４を有する点に特徴がある。

【００２０】送信装置１は、伝送すべき情報を遅延する遅延回路２と、この遅延回路２の出力信号が受信機用信号ａとして、また伝送すべき情報が中継装置用信号ｂとしてそれぞれ入力されて、これらの信号を階層化しＯＦＤＭ変調する階層変調回路３と、階層変調回路３の出力信号を増幅及び高周波の送信帯域に周波数変換して空中線５を介して送信する送信高周波数部４から構成されている。なお、階層変調回路３では、受信機用信号ａは低次（低搬送波電力対雑音電力比（Ｃ／Ｎ）時も受信可能）側に、中継装置用信号ｂは高次（低Ｃ／Ｎ時には受信不能）側に階層変調する。階層変調回路３は、例えば図２のブロック図に示すように、マッピング回路６と、逆高速フーリエ変換（ＩＦＦＴ）回路７と直交変調回路８とからなる。

【００２１】中継装置１１は、送信装置１からの電波２１を受信する空中線１２と、空中線１２からの受信信号から所要周波数帯域の信号を抽出、増幅する受信高周波部１３と、受信高周波部１３からの受信高周波信号をＯＦＤＭ復調して、階層化された信号を分離し、更に高次側の信号である中継装置用信号ｃを得る階層復調回路１４と、中継装置用信号ｃをＯＦＤＭ変調する変調回路１５と、変調回路１５の出力ＯＦＤＭ信号を増幅及び高周波数帯に変換する送信高周波部１６と、送信高周波部１６の出力高周波信号を電波２３として送信する空中線１７とから構成されている。階層復調回路１４は例えば図３のブロック図に示すように、直交復調器１８と、高速フーリエ変換（ＦＦＴ）回路１９と、判別回路２０から構成されている。

【００２２】なお、空中線１７から送信される電波２３の周波数は、送信装置１からの電波２１及び２２と同じ周波数とする。また、受信機２５は、送信装置１から送信された電波２２と中継装置１１から送信された電波２３とを空中線２４で受信後復調する。

【００２３】次に、この実施の形態の動作について、図４及び図５を併せ参照して詳細に説明する。図４（Ａ）は送信装置１が設置された送信点３１、中継装置１１が設置された中継点３２、受信機２５の位置である受信点３３の位置関係を示す図であり、ｔ１、ｔ２及びｔ４はそれぞれ送信点３１と受信点３３の間、送信点３１と中継点３２の間、及び中継点３２と受信点３３の間の電波伝搬に要する遅延時間を示し、ｔ３は中継点３２に設置された中継装置１１での処理時間、つまり再送信に必要な遅延時間を示す。

【００２４】受信点３３では、送信点３１から送られてくる電波３４と中継点３２から送られてくる電波３６とを同時に受信する。いま、中継点３２に設置された中継装置１１が送信点３１から送られてきた電波３５を単に増幅して再送信するものであるとすると、受信点３３では送信点３１から送られてくる電波３４と、中継点３２から送られてくる電波３６との間に（ｔ２＋ｔ３＋ｔ４－ｔ１）なる遅延時間差を生ずる。

【００２５】図４（Ｂ）はこのときの電波３４の信号３７と電波３６の信号３８との受信点３３における時間関係を示す図である。信号３７及び３８は同じ内容の信号であるが、遅延時間差ｔ５を生じている。この遅延時間差ｔ５は前記遅延時間差（ｔ２＋ｔ３＋ｔ４－ｔ１）である。それぞれの信号３７及び３８は情報ｄ１とガードインターバルｄ２から１シンボルを構成している。ＯＦＤＭ復調には、この１シンボル期間内の任意の期間から情報ｄ１の部分に相当する長さの期間を抽出する。

【００２６】図４（Ｂ）においては、復調区間ｔ６がこれに相当する。しかし、信号３７と信号３８との遅延時間差ｔ５が大きく、信号３７と信号３８とが合成された場合には、シンボル間干渉区間ｔ７を生ずる。このシンボル間干渉区間ｔ７では、異なる情報を持つシンボルが合成されるため、復調後に本来の情報に誤りを生ずる。つまり、遅延時間差ｔ５がガードインターバルｄ２の期間よりも長い場合には、少なくともその時間差に相当するシンボル間干渉区間ｔ７を生じ、誤りを生ずる。

【００２７】本実施の形態はこのシンボル間干渉区間を生じさせないことを目的とするものであり、送信装置１と中継装置１１とにより図４（Ａ）に示す（ｔ２＋ｔ３）に相当する遅延時間の補償を行うことにより、遅延時間差ｔ５を（ｔ４－ｔ１）とするものである。図４（Ｃ）はこのときの電波３４の信号３７と電波３６の信号３８との受信点３３における時間関係を示している。同図に示すように、遅延時間差ｔ５がガードインターバルｄ２の期間よりも短く、シンボル干渉区間を生じない。

【００２８】次に、階層変調について図５と共に説明する。図５（Ａ）はノンユニフォーム１６ＱＡＭ（直交振幅変調）のコンスタレーションを示すものであり、図中の４桁の数字は各信号点に割り当てられた４ビットの符号を示す。各数字の上位２ビットは各信号点が位置する象限に対応しており、下位２ビットは各象限内の信号点の位置に対応している。上位２ビットについては、各符

号の距離が大きく、低Ｃ／Ｎでの伝送が可能であるが、下位２ビットについては、各符号の距離が小さく上位２ビットに比較して高いＣ／Ｎが要求される。従って、低次（低Ｃ／Ｎ時も受信可能）側の情報を上位２ビットに割り当て、高次（低Ｃ／Ｎ時には受信不能）側の情報を下位２ビットに割り当てることにより、階層変調が可能となる。

【００２９】また、上位２ビットについては、図５（Ｂ）に示すＱＰＳＫ（４相位相変調）のコンスタレーションと同じ数字が割り当てられている。従って、図５（Ａ）に示すノンユニフォーム１６ＱＡＭの信号のうち、低次（低Ｃ／Ｎ時も受信可能）側の信号のみが受信できればよい場合には、ノンユニフォーム１６ＱＡＭの信号を図５（Ｂ）に示すＱＰＳＫの信号として処理を行うことができる。

【００３０】図５（Ｃ）はノンユニフォーム１６ＤＡＰＳＫ（差動振幅位相変調）のコンスタレーションを示すものである。図中の４桁の数字は各信号点に割り当てられた４ビットの符号を示す。この場合も、ノンユニフォーム１６ＱＡＭと同じく、上位２ビットは各信号点が位置する象限に対応しており、下位２ビットは各象限内の信号点の位置に対応している。従って、同様に低次（低Ｃ／Ｎ時も受信可能）側の信号のみが受信できればよい場合には、ノンユニフォーム１６ＤＡＰＳＫの信号を図５（Ｂ）に示すＱＰＳＫの信号として処理を行うことができる。

【００３１】再び図１に戻って動作について説明するに、送信装置１において、伝送すべき情報は２分配され、一方は遅延回路２により所定時間遅延される。この遅延時間は、送信装置１と中継装置１１との間を電波２１が伝搬する時間（図４（Ａ）のｔ２）に、中継装置１１の信号処理に要する時間（図４（Ａ）のｔ３）を加算した時間とする。従って、図４（Ａ）に示した例では、この遅延時間は（ｔ２＋ｔ３）に設定され、遅延時間差ｔ５を（ｔ４－ｔ１）とする。遅延回路２により遅延された信号は、受信機用信号ａとなる。遅延回路２の遅延時間をこのように定めることにより、送信装置１と中継装置１１とから同じタイミングで情報を送信することができる。

【００３２】２分配された伝送すべき情報の他方は、中継装置用信号ｂとして直接に階層変調回路３に供給される。階層変調回路３は上記の中継装置用信号ｂと遅延回路３よりの受信機用信号ａとを入力信号として受け、これらを階層化した上でＯＦＤＭ変調を行う。すなわち、階層変調回路３は図２のブロック図に示す構成とされており、入力された受信機用信号ａと中継装置用信号ｂとをマッピング回路６においてＯＦＤＭ信号を構成する各搬送波へそのデータが割り振られると共に、図５（Ａ）又は図５（Ｃ）に示すＩ，Ｑ軸からなる複素平面上に、受信機用信号ａと中継装置用信号ｂがそれぞれ低次側、高次側に配置されることにより、階層化される。

【００３３】ここで、階層化には図５（Ａ）に示したコンスタレーションのノンユニフォーム１６ＱＡＭや、同図（Ｃ）に示したコンスタレーションのノンユニフォーム１６ＤＡＰＳＫが使用され、受信機用信号ａには上位２ビット（低次（低Ｃ／Ｎ時も受信可）側）を割り当て、中継装置用信号ｂには下位２ビット（高次（低Ｃ／Ｎ時には受信不能）側）を割り当てる。この結果、受信機２５へ向けた情報（すなわち、受信機用信号ａ）は、低Ｃ／Ｎ時にも受信可能となる。

【００３４】図２において、ＩＦＦＴ回路７はＯＦＤＭ信号を構成する多数の搬送波の数に相当する数の複素信号入力部（実数部入力部と虚数部入力部）を有しており、マッピング回路６から出力された、図５（Ａ）又は同図（Ｃ）に示したＩ，Ｑ軸からなる複素平面上の座標に相当する信号が、対応する入力部に入力されて複素の逆フーリエ変換を行うことにより、周波数軸上の入力信号を時間軸上の複素信号（データシンボル列）に変換する。この複素信号は直交変調器８に供給されて直交変調されることにより、高周波数のＯＦＤＭ信号とされる。

【００３５】階層変調回路３より取り出されたＯＦＤＭ信号は、図１に示した送信高周波部４により増幅及び送信周波数帯に周波数変換された後、空中線５から中継装置１１及び受信機２５に対して電波２１、２２として送信される。

【００３６】中継装置１１においては、送信装置１からの電波２１を空中線１２により受信し、受信高周波部１３で所要周波数帯域の信号を抽出、増幅した後に階層復調回路１４によりＯＦＤＭ復調し、階層化された信号を分離する。すなわち、階層復調回路１４は図３のブロック図に示す構成とされており、受信信号を直交復調器１８により直交復調して時間軸上の複素信号を得、その複素信号をＦＦＴ回路１９に供給して複素の高速フーリエ変換させることにより、周波数軸上の受信信号を出力させ、更にこの受信信号を判別回路２０に供給して順次しきい値との比較によりＩ，Ｑ軸に対応したディジタル信号を復調出力する。

【００３７】中継装置１１において、ノンユニフォーム１６ＱＡＭ信号を復調する場合、ノンユニフォーム１６ＱＡＭのコンスタレーションが６４ＱＡＭのコンスタレーションの部分集合である場合には、判別回路２０では６４ＱＡＭとしての判別、つまりＩ，Ｑの各軸においてそれぞれ等間隔の８段階の値をとるものとして、通常の６４ＱＡＭ信号と同様のしきい値により判別することができる。

【００３８】中継装置１１においては、階層変調されたノンユニフォーム１６ＱＡＭの情報のうち、高次側の中継装置用信号ｂの情報のみが再送信のために必要であり、低次側の受信機用信号ａの情報は不要であるので、ノンユニフォーム１６ＱＡＭ信号を判別した結果のう

ち、象限の情報（図５（Ａ）に示した上位２ビット）は捨てられ、象限内の情報（図５（Ａ）に示した下位２ビット）のみを出力し、図１の変調回路１５へ供給する。

【００３９】すなわち、階層復調回路１４は送信装置１の階層変調回路３により高次（低Ｃ／Ｎ時には受信不能）側に割り当てられた中継装置用信号のみを出力するようになされている。中継装置１１は、ビルの屋上や山の頂上等の受信環境の良い所に設置することが可能なため、一般の受信機よりも高いＣ／Ｎで送信装置１からの電波２１を受信することができるので、高次（低Ｃ／Ｎ時には受信不能）側に割り当てられた信号でも十分に誤りなく復調することができる。

【００４０】階層復調回路１４の出力信号、つまり中継装置用信号ｃは変調回路１５に供給され、ここでＱＰＳＫによるＯＦＤＭ変調された後、送信高周波部１６により送信装置１からの電波２１と同一周波数に変換され、空中線１７から受信機２５に対して電波２３として送信される。

【００４１】受信機２５においては、送信装置１から送信された電波２２と中継装置１１から送信された電波２３とを空中線２４で受信する。送信装置１から送信された電波２２は、中継装置用の情報を含むノンユニフォーム１６ＱＡＭやノンユニフォーム１６ＤＡＰＳＫで各搬送波が変調されたＯＦＤＭ信号であり、一方、中継装置１１から送信された電波２３はＱＰＳＫで各搬送波が変調されたＯＦＤＭ信号であり、変調方式が異なる。しかし、受信機２５では電波２２及び２３のうち低次（低Ｃ／Ｎ時も受信可能）側の信号のみが受信できればよく、また、前述したように、電波２２のノンユニフォーム１６ＱＡＭの信号、あるいはノンユニフォーム１６ＤＡＰＳＫの信号を、電波２３と同じＱＰＳＫの信号として処理を行うことができるため、受信機２５は両電波を同時に受信して両者が合成された信号をＱＰＳＫの信号として復調できることとなる。

【００４２】このように、この実施の形態によれば、送信装置１と中継装置１１との情報送信のタイミングを一致させることが可能であるため、従来と同じガードインターバル期間の場合は従来よりも送信装置１と中継装置１１との距離を長くすることができ、サービスエリアを拡大できる。また、送信装置１と中継装置１１との距離が従来と同じ場合は、冗長な期間であるガードインターバルの期間を短くすることが可能となり、これにより伝送する情報量を増加できる。

【００４３】また、中継装置１１へは階層変調した情報を送信するようにしているので、送信装置１から受信装置２５へ向けた信号に中継装置１１へ向けた情報を重畳することができ、専用の回線を不要にできる。

【００４４】次に、本発明になる中継装置の第２の実施の形態について説明する。図６（Ａ）は本発明になる中継装置の第２の実施の形態のブロック図を示す。同図中、図１と同一構成部分には同一符号を付し、その説明を省略する。図６（Ａ）に示す第２の実施の形態の中継装置４１は、図１に示した中継装置１１に遅延回路４３を付加することにより、中継点が複数の場合に使用可能としたものである。

【００４５】すなわち、図１に示した第１の実施の形態は送信点と中継点とが各１個所の場合の例であるが、中継点が複数要求される場合もあり得る。図６（Ｃ）は中継点が５２及び５３で示す如く、送信点５１に対して２個所設けられた位置関係を示す。この場合、送信点５１と中継点５２の間の電波伝搬に要する遅延時間はｔ８で、送信点５１と中継点５３の間の電波伝搬に要する遅延時間はｔ９であり、それらの遅延時間ｔ８及びｔ９は等しくなく、それらの距離も等しくないものとする。

【００４６】このような場合には、図１に示した遅延回路２の遅延時間を一意に定めることはできない。そこで、この第２の実施の形態の中継装置４１は、このような場合に、図１に示した遅延回路２の遅延時間を一意に定めることができるようにした中継装置である。図６（Ａ）に示した中継装置４１を使用するに当っては、図１に示した遅延回路２の遅延時間を、中継点と送信点との間の電波伝搬に要する遅延時間に中継装置の信号処理による遅延時間を加えた合計の遅延時間が最大になる中継装置の遅延時間に合わせる。この結果、遅延時間が最大になる中継装置以外の中継装置では、送信点よりも早いタイミングで信号を送信することとなる。

【００４７】図６（Ａ）に示す中継装置４１では、このタイミングのずれを防止するために、遅延回路４３が階層復調回路１４の出力に設けられ、階層復調回路１４の出力復調信号を遅延して変調回路１５に供給する。この遅延回路４３の遅延時間は、当該中継装置が位置する中継点と送信点との間の電波伝搬に要する遅延時間に、当該中継装置の信号処理による遅延時間を加えた合計の遅延時間に対しての送信装置に設けられた遅延回路２の遅延時間の差に設定される。これにより、送信点と各中継点のタイミングが一致する。

【００４８】例えば、図６（Ｃ）において、ｔ９＞ｔ８であり、かつ、中継点５２及び５３のそれぞれにおいて中継処理のために時間ｔ３を要するものとすると、送信点５１に配置された送信装置１内の遅延回路２の遅延時間は（ｔ９＋ｔ３）に設定され、中継点５３の中継装置と送信点５１の送信装置１とから実質的に同じタイミングで情報を送信させる。

【００４９】更に、この場合、中継点５２の中継装置４１内の遅延回路４３の遅延時間は（ｔ９－ｔ８）に設定される。これにより、送信点５１に配置された送信装置１と中継点５２及び５３にそれぞれ配置された中継装置４１の送信タイミングが実質的に一致する。なお、中継点５３に配置される中継装置は図１に１１で示した中継装置と、図６（Ａ）に示した中継装置４１のいずれも使

用可能であるが、中継装置４１の場合は遅延回路４３の遅延時間は０に設定される。

【００５０】なお、遅延回路４３はディジタル信号を遅延させる回路であるため、ディジタル処理が可能である。具体的には、メモリを使用し、その書き込み番地と読み出し番地との間の差により遅延時間を定めることができる。従って、遅延時間の設定変更を容易に行える。

【００５１】次に、本発明になる中継装置の第３の実施の形態について説明する。図６（Ｂ）は本発明になる中継装置の第３の実施の形態のブロック図を示す。同図中、図１と同一構成部分には同一符号を付し、その説明を省略する。図６（Ｂ）に示す第３の実施の形態の中継装置４５は、図１に示した中継装置１１に遅延回路４７を付加することにより、第２の実施の形態と同様に、中継点が複数の場合に使用可能としたものである。ただし、第２の実施の形態では、遅延回路４３を階層復調回路１４の出力側に設けたが、この第３の実施の形態の中継装置４５では、図６（Ｂ）に示すように、遅延回路４７を階層復調回路１４の入力側に設けた点に特徴がある。

【００５２】遅延回路４７の遅延時間及び動作は第２の実施の形態の遅延回路４３のそれと同様であるので説明は省略する。この遅延回路４７はアナログ、ディジタルのどちらでも構成することができる。ディジタル処理の場合は、第２の実施の形態と同様に、メモリの書き込み、読み出しの番地制御により遅延時間を定めることができる。また、アナログ処理の場合には、高い周波数帯での処理が可能なため、公知のＳＡＷ（表面弾性波）素子による遅延線を使用することも可能であり、この場合には遅延時間の設定の自由度は低いが小型化が可能である。

【００５３】上記の第２及び第３の実施の形態の中継装置４１、４５を用いた中継方式は、第１の実施の形態と同様の特長を有すると共に、中継点が複数ある中継方式に適用可能であるという特長を有する。

【００５４】

【発明の効果】以上説明したように、本発明によれば、送信装置内の同一の送信部から受信機と中継装置の両方に向けてそれぞれの信号を同時に送信することができるため、中継装置用の回線を不要にできる。

【００５５】また、本発明によれば、中継装置から受信機へ再送信される信号と、送信装置から受信機へ送信される受信機用信号の送信タイミングをほぼ一致させることで、これらの信号が送信装置と中継装置において常に同じ情報内容としたため、従来の中継方式に比較し、受信機における送信装置から送信される電波と中継装置から再送信される電波との間の遅延時間差は２分の１以下にでき、よって、従来の中継方式と同じガードインターバル期間の場合は送信装置と中継装置との距離を長くすることができ、サービスエリアを拡大することができる。

【００５６】また、本発明によれば、送信装置と中継装置の距離が従来の中継方式と同じ場合では、冗長な期間であるガードインターバルの期間を低減することができるため、伝送する情報量を従来よりも増加させることができる。

【００５７】更に、本発明によれば、送信装置は中継装置が複数ある場合に、伝送すべき情報を送信点から複数の各中継点までのそれぞれの電波伝搬時間に各中継点に配置されている複数の中継装置の信号処理時間を加えた時間のうち、最大の時間を遅延時間として遅延回路に設定した構成とし、中継装置は送信装置の送信時刻と、自装置が送信する時刻とをほぼ一致させるための遅延回路を、階層復調回路の入力側又は出力側に設け、複数の中継装置から受信機へ再送信される信号と、送信装置から受信機へ送信される受信機用信号の送信タイミングをほぼ一致させるようにしたため、複数の中継装置が存在する中継方式においても、上記の各効果を損なうことのないシステムを構築できる。

【００５８】更に、本発明によれば、ビルの屋上などの受信環境の良い所に設置することが可能な中継装置では、一般の受信機よりも高いＣ／Ｎで送信装置からの電波を受信できるため、受信機用信号は低次側に、かつ、前記中継装置用信号は高次側に階層変調することにより、受信機用信号及び中継装置用信号ともに十分誤りなく受信復調することができる。

【００５９】また、更に、本発明は基本的にはＳＦＮであるため、ＤＦＮに比し周波数利用効率が良く、また移動受信にも適している。

【図面の簡単な説明】

【図１】本発明の第１の実施の形態のブロック図である。

【図２】図１中の階層変調回路の一例のブロック図である。

【図３】図１中の階層復調回路の一例のブロック図である。

【図４】中継方式における送信点、中継点及び受信点の位置関係と、信号の時間関係の説明図である。

【図５】図１における階層変調回路を説明するコンスタレーション図である。

【図６】本発明の中継装置の第２及び第３の実施の形態のブロック図と、送信点と中継点との電波伝搬時間等の説明図である。

【符号の説明】

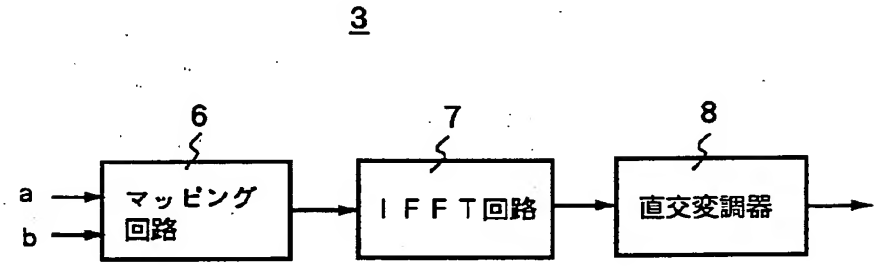
1　送信装置
2　遅延回路
3　階層変調回路
4　送信高周波部
6　マッピング回路
7　逆高速フーリエ変換（ＩＦＦＴ）回路

13　　14

８　直交変調器
１１、４１、４５　中継装置
１３　受信高周波部
１４　階層復調回路
１５　変調回路
１６　送信高周波部
１８　直交復調器
１９　高速フーリエ変換（ＦＦＴ）回路
２０　判別回路
２１～２３　電波
＊２５　受信機
３１、５１　送信点
３２、５２、５３　中継点
３３　受信点
４３、４７　遅延回路
ａ　受信機用信号
ｂ、ｃ　中継装置用信号
ｄ１　情報
ｄ２　ガードインターバル
＊10

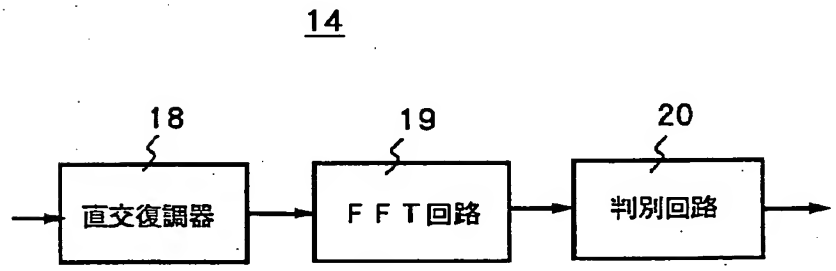
【図２】

図１中の階層変調回路の一例のブロック図



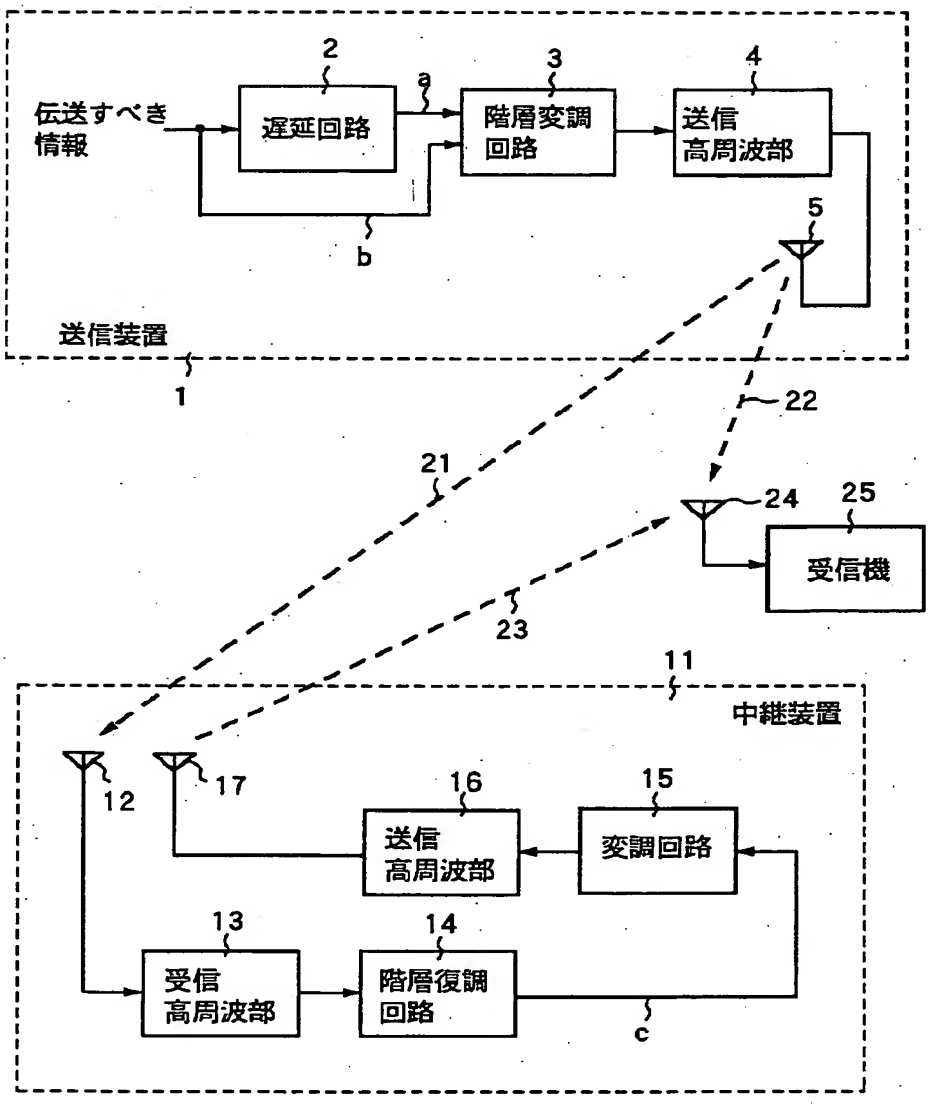
【図３】

図１中の階層復調回路の一例のブロック図



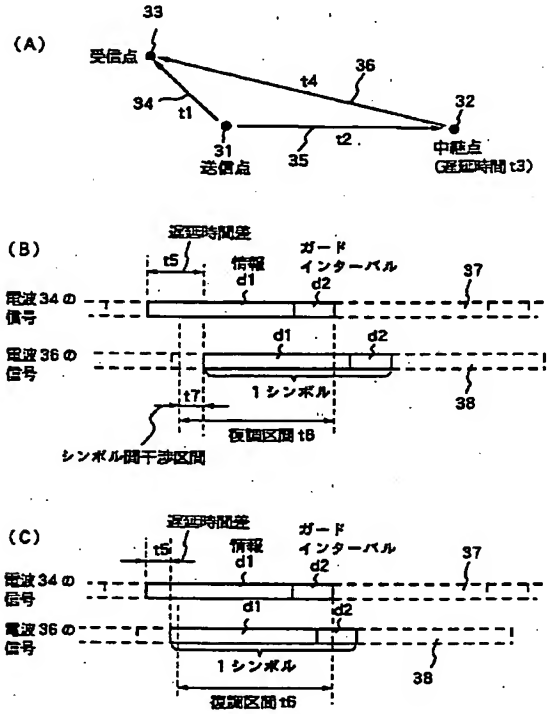
【図１】

本発明の第１の実施の形態のブロック図



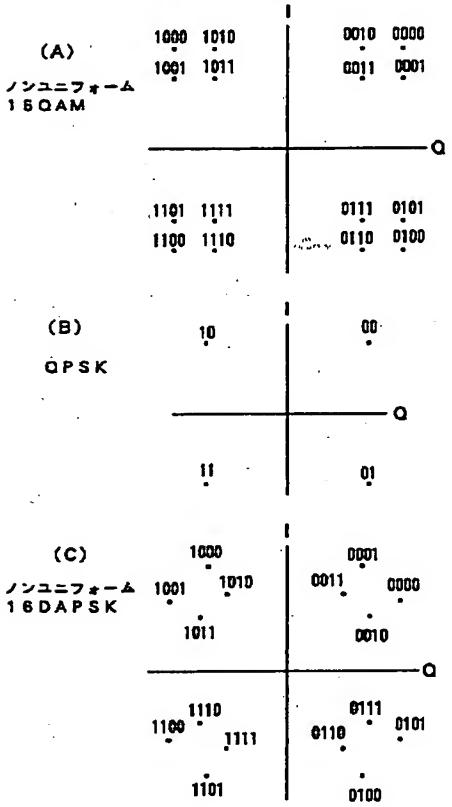
【図４】

中継方式における送信点、中継点及び受信点の位置関係と信号の時間関係説明図



【図５】

図１における階層変調回路を説明するコンスタレーション図



【図６】

本発明の中継装置の第2、第3の実施の形態のブロック図と、送信点と中継点との電波伝搬時間等の説明図